Compressed Air Magazine

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MARCH, 1929

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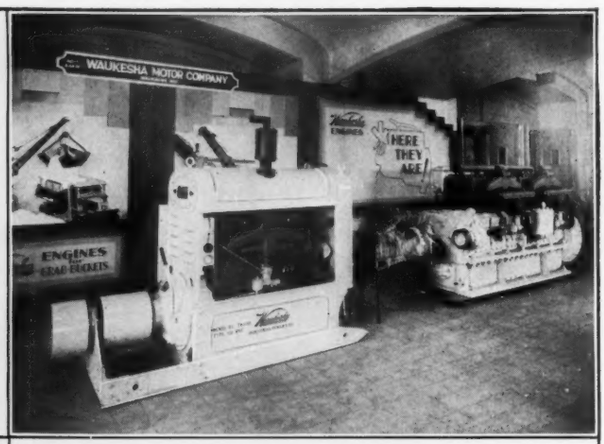
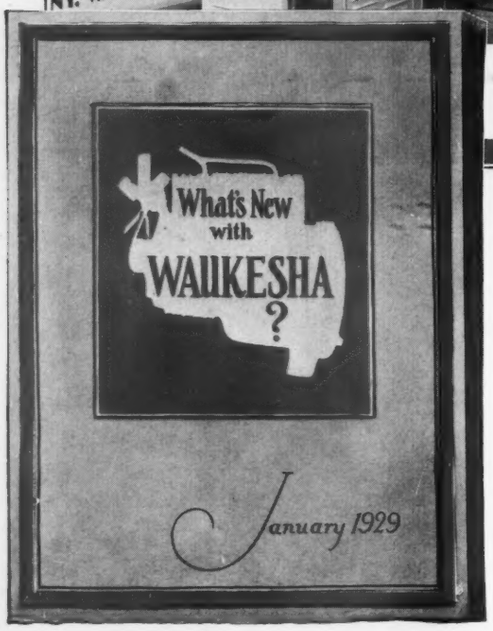
PULLING A PORTABLE COMPRESSOR UP A LONG SLOPE OF 40 DEGREES TO DRIVE A DEEP OPEN CUT FOR DIVERTING A MOUNTAIN STREAM



1929 Road Show



The Road Show at Cleveland, in January, brought forth the best that the most prominent builders of contractors' machinery have been able to develop for the 1929 demand. Shovels, cranes, skimmers, rollers were all attractively displayed for contractors, commissioners and others interested in the making and repairing of roads.

The Waukesha Motor Company was present with a showing of nine new models, including the season's outstanding development, The Great Six. This engine and other new Waukesha models are fully described in the Bulletin, "What's New with Waukesha?"

For the contractors and machinery manufacturers who did not attend the show, bulletin No. 710, "What's New with Waukesha?" is available upon request. This 20-page bulletin describes and illustrates the new Waukesha engine models for both automotive and industrial use. Write for your copy.

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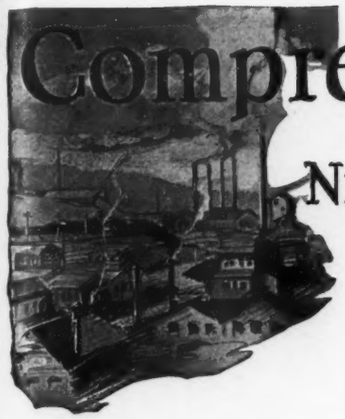

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VOL. XXXIV, No. III

MARCH, 1929

Pennsylvania Slate Quarries Adopt New Mechanical Aids

Use of Wire Saw and Calyx Drill Promises to Put Industry On More Profitable Footing

By R. G. SKERRETT

PENNSYLVANIA'S world-famed slate quarries, in the so-called "soft-vein" region of Lehigh and Northampton counties, are in the throes of an operating revolution that promises to bring about very substantial savings in time, money, and waste material.

Today, for every cubic foot of marketable slate produced there are scores of cubic feet of slate quarried that go only to upbuild mountainous piles of waste. These accumulations clutter the ground around every quarry, and represent anywhere from 70 to 85 per cent of the slate removed from the associate pit. This waste, of course, must be covered in the selling price of the finished product; and one may be excused for wondering how a business so hampered could endure despite the undisputed excellence of its commodities.

Slate is admirably and peculiarly suited to many services; and nature has been generous to man in providing this adaptable raw material in deposits of vast extent. But in this age of substitutes and keen competition the buying public thinks primarily of price and gives comparatively little heed to fundamental merits—especially if skillful and persistent advertising proclaims the "just-as-good" attributes of the artificial products. The slate industry, as a whole, has not promoted its interests through broadcast publicity.

During 1927, slate to the value of $10,873,000 was sold at the quarries in the United States; and the largest single item in the business was that of roofing slate, representing an output of 450,000 squares valued at $4,510,000, or substantially 41.5 per cent of the total sales. The dominating position of roofing slate is one that it enjoys of ancient right, because slate roofing has been known to the civilized world for centuries. There is a slate-roofed Saxon chapel in Wiltshire, England, that was built in the eighth century; and that roof is still in good condition after 1,200 years of exposure to seasonal and weather changes. This is merely one among many ancient examples of the utilization of slate for this purpose because of the enduring nature of the material.

According to the United States Bureau of Mines: "Slate makes such durable and attractive roofing that its use should be greatly encouraged. Furthermore, its noninflammability as compared with wood adds to its value, for the most frequent cause of dwelling-house fires in the United States is said to be sparks from a chimney alighting on a wood-shingle roof." In short, the use of slate for this purpose means fewer fires, better roofs, and greater protection to life and property.

The quarrying of slate for roofing had its beginning in America about 1735; but the industry did not become an established one much before 1850. Its inception and expansion here have been largely due to the activities of Welshmen who worked in the slate quarries of Cornwall before coming to the United States. These pioneers were used to hand methods in getting the slate out of the ground and in afterwards shaping it for the market. Their conservatism long made them reluctant to adopt mechanical aids—thus placing the industry at a disadvantage subsequently when substitute roofings were produced and offered at prices within the reach of the purses of a wide range of householders.

Within the last ten years, the outlook for the slate industry was much improved by the increasing employment of quarrying machinery and also by the utilization of milling equipment that have greatly reduced dependence upon handwork. But notwithstanding these

AN industry with a loss of 85 per cent in getting its raw product into marketable form does not sound like a business founded on modern methods, and yet, in general terms, this has been the handicap under which the slate industry of this country has labored for many years. It was this appalling loss that put many of the slate quarries and mills at a great disadvantage in competition with people that actually used quarry waste in manufacturing their products. Happily, the foregoing situation has been radically altered for the better in certain Pennsylvania slate quarries through the adoption of facilities that make it practicable not only to save money in quarry operations but to turn out an astonishingly increased volume of sound stone and, therefore, an increased measure of marketable slate from each ton of raw material. We refer to the betterments made possible by utilizing the wire saw and the Calyx drill in connection with that saw. What has been done in Pennsylvania should be of much interest to the slate industry at large as well as to other producers of stone.

Left—Tension post of wire saw in the quarry of the Chapman Slate Company. Right—Tension post and two 36-inch holes made with a Calyx drill in the same quarry.

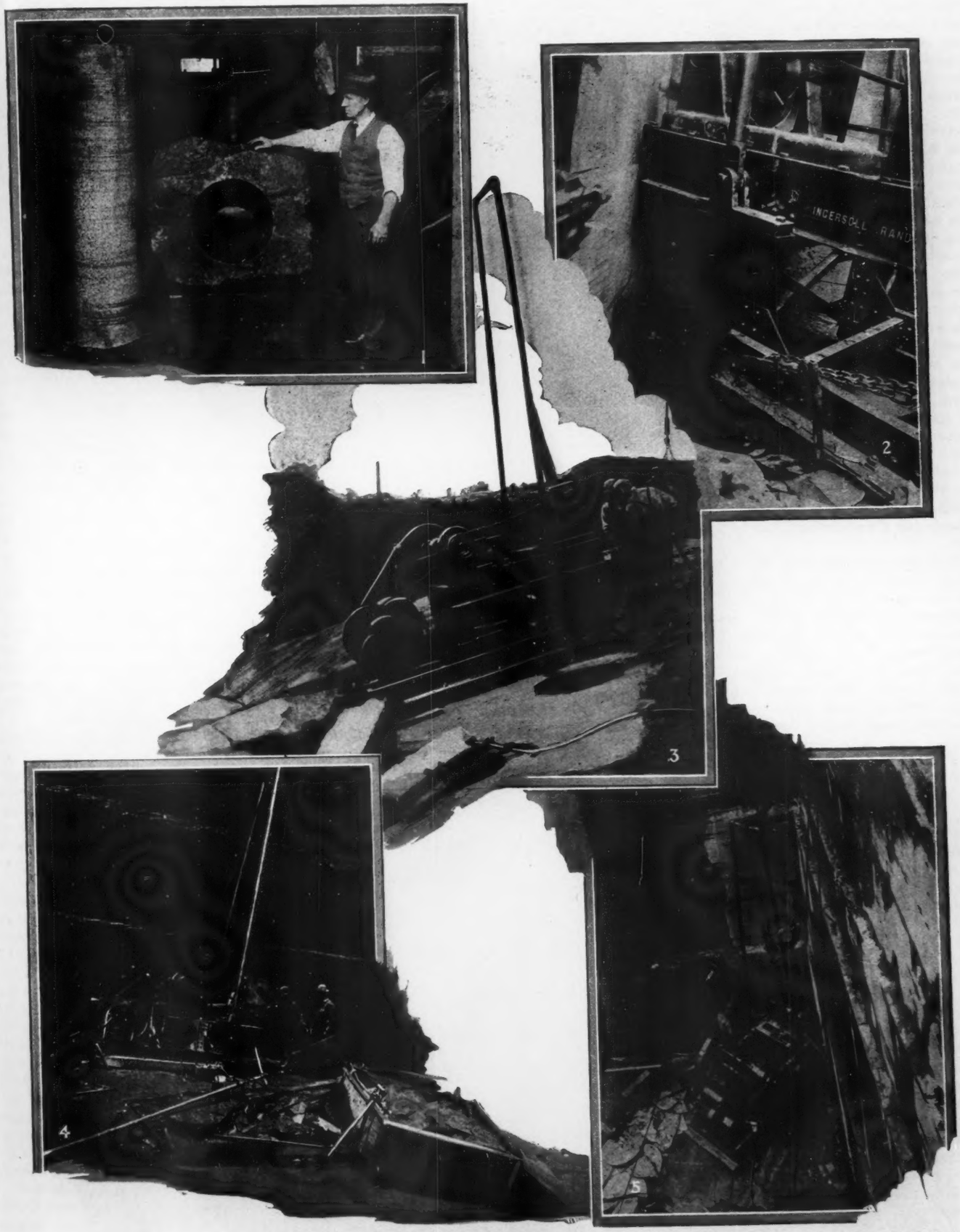
concessions to the march of engineering progress that have amplified the marketable forms of slate and the services to which it can be put, still the waste in the quarry has remained unfortunately high—handicapping the industry economically and placing it at a serious disadvantage in the competitive field of business. Before telling what has been done through the aid of the Government to place the industry in a better position, let us describe briefly the origin and the nature of slate as well as some of the present-day outstanding uses to which it can be advantageously put.

As understood by technologists, slate is a fine-grained rock, characterized by a more or less perfect cleavage, that can be readily split into thin, smooth sheets. This explains why slate was early used as a roofing material. Slates differ widely in color and also in their mineral and chemical compositions. With few exceptions, the slates of commerce are of sedimentary origin; and the primary deposits from which they evolved contained large percentages of clay which was originally admixed with lesser quantities of quartz, mica, lime, magnesia, feldspars, iron, and carbonaceous matter. In the course of time, forces continually at work in the crust of the earth subjected the subaqueous deposits to high pressures and to heat. The pressures changed the arrangement of the mineral grains, causing the long axes of the grains to lie generally parallel so that the rock will split easily in one direction. The "slaty cleavage", as this characteristic is called, is so pronounced in some Pennsylvania slates that they can be split in sheets as thin as $\frac{1}{32}$ of an inch. The high temperatures to which the forming slates were subjected in ages gone altered the original mineral constituents—producing mica, quartz, chlorite, etc.

Most of the commercial slates quarried in the United States are what are known as "mica slates". They are more resistant to absorption than are "clay slates", and, therefore, more enduring. In fact, the mineral composition of the average American slate is represented by from 38 to 40 per cent of mica and by from 31 to 45 per cent of quartz. No wonder, then, that a slate roof will last for generations. Slates quarried near Delta, Pa., in 1734, were doing service on their seventh building in 1910, and apparently without any change in color or evidences of deterioration.

Because of the ample and the cumulative proofs of the enduring qualities of high-grade

Breaking blocks of slate loose from a quarry floor.



1—Granite core, 20 inches in diameter, cut with a Calyx drill adapted experimentally for slate-quarry work. 2—One of the WS Calyx drills taking out a 36-inch core in the quarry of the Colonial Slate Company. 3—Calyx drill having just completed a 36-inch hole in the quarry of the Chapman Slate Company. 4—Calyx drill, in the quarry of the Parsons Brothers Slate Company, with part of a 36-inch core removed. 5—Here the Calyx drill is taking out a 36-inch core in the corner of a quarry floor.

mica slate, it is not hard to understand why our slate producers, especially in latter years, have found fairly numerous ways in which slate could be put to service. One of the largest uses of mill stock—roofing not being classed with mill stock—is for blackboards and bulletin boards. To a lesser degree it goes into the making of school slates, now employed more abroad than in this country. The best blackboard slate in the world is obtained from the soft-vein region of Pennsylvania; and that slate is noted because of its smoothness, uniformity, permanence, and attractiveness. Needless to say, it is far superior and infinitely more lasting than the painted blackboards commonly seen in schools and elsewhere a quarter of a century ago.

Looking down into the quarry of the Parsons Brothers Slate Company, Pen Argyl, Pa.

Structural slate, according to the trade use of the term, does not apply either to roofing slate or to slate for blackboards; slate so designated is largely utilized for interior structural and sanitary purposes. The principal structural slate products are mantels, floor tiles, steps, risers, flagging, skirting board, window sills, wainscoting, hearths, sinks, lavatory slabs, laundry tubs, vats, flour bins, dough troughs, refrigerator shelves, sanitary ware, billiard and other table tops, lamp bases, well caps, grave vaults, etc., etc.

During 1927, a total of 1,627,000 square feet of slate, valued at $1,292,000, was used for electrical switchboards, etc. Slate for this purpose must have ample mechanical strength and be of low electric conductivity. The structural slate produced in 1927 required 2,350,000 square feet of mill stock, valued at $880,000; and the blackboards and bulletin boards turned out in the same period called for 3,440,000 square feet of mill stock, valued at $1,070,000.

In addition to the foregoing commodities, a considerable quantity of crushed slate and slate flour was made and marketed in 1927. Crushed slate and slate flour are, to a large extent, by-products of the ndustry — representing the use of slate that would otherwise go to waste. Last year the output of roofing granules and flour, estimated at 456,600 short tons, had a value at the quarry or mill of $2,775,000.

While granules and flour provide ways for the profitable utilization of slate that is generally scrapped, still this use does not materially reduce the wastage losses widely prevalent in the industry—losses for the most part attributable to the methods generally employed in getting the slate out of the ground. Recognizing the need of betterment, if the industry were to prosper in the face of competitive products, the United States Bureau of Mines began an investigation of the slate industry a few years ago. As an outcome of the inquiry conducted for the bureau by Dr. Oliver Bowles, the slate producers of the so-called soft-vein reg of Pennsylvania rapidly placing the selves in a position t will enable them to duce their annual los through waste and, i dentally, to incre their marketable sl anywhere from 100 150 per cent from given quantity of qu ried stone! The e nomic significance of t improvement can be stated in conclus figures; but it is lik to be momentous a is certainly a hearte ing turn in the road th our slate producers ha traveled heretofore.

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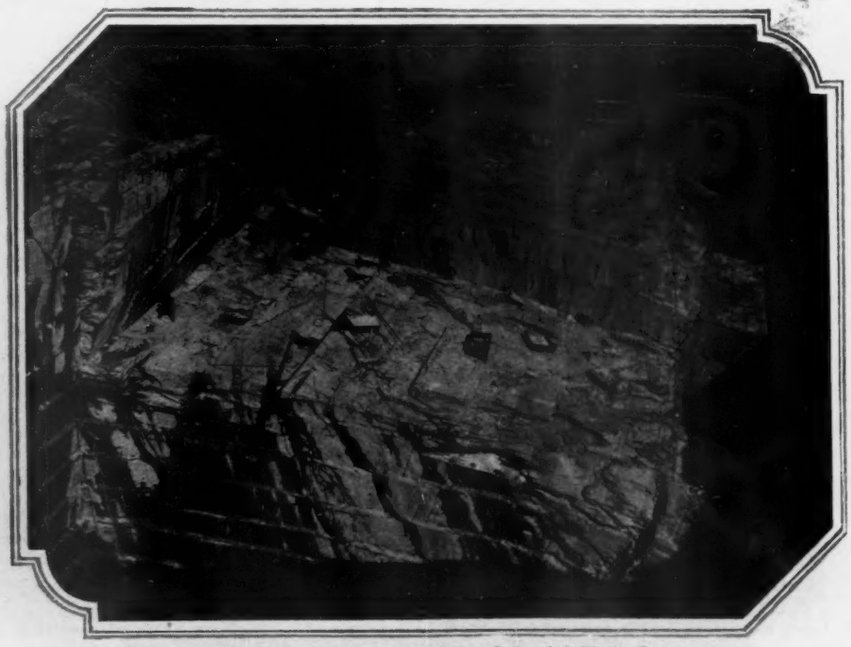
In Pennsylvania the high-grade slates a commonly found in relatively narrow be that are frequently inclined at steep angle sometimes nearly vertical; and, as a cons quence, the quarries are often several hundre feet deep—growing co tinually deeper as th operator follows down ward the beds of de sirable slate. His aim i to get out good-size blocks of sound mate rial—that is, material a little shattered as po sible during quarrying. Even with the best me chanical facilities avail able for making the pri mary cuts that free the rock from the envelop ing quarry walls and that divide the quarry floor into rectangular sections for splitting and breaking into blocks that can be hoisted to the ground level, still the rock on either side of these cuts may be "stun ned" or shattered from one foot to several feet. This shattered stone



Wire-saw set-up in the quarry of the Colonial Slate Company.

1—Wire saw set-up in the Parsons Brothers' slate quarry. 2—Close-up of a wire saw set-up in a 36-inch hole made with a Calyx Drill. 3—Bottom of a cut showing saw and issuing stream of sand and water. 4—This 95-foot cut was made with a wire saw. 5—This double set-up is operated by a single motor driving one cutting wire arranged to make two simultaneous cuts.

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In Pennsylvania the high-grade slates are commonly found in relatively narrow beds that are frequently inclined at steep angles, sometimes nearly vertical; and, as a consequence, the quarries are often several hundred feet deep—growing continually deeper as the operator follows downward the beds of desirable slate. His aim is to get out good-sized blocks of sound material—that is, material as little shattered as possible during quarrying. Even with the best mechanical facilities available for making the primary cuts that free the rock from the enveloping quarry walls and that divide the quarry floor into rectangular sections for splitting and breaking into blocks that can be hoisted to the ground level, still the rock on either side of these cuts may be "stunned" or shattered from one foot to several feet. This shattered stone

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Left—In a hand-splitting shed where roofing slates are made. Right—Piles of seasoned roofing slates.

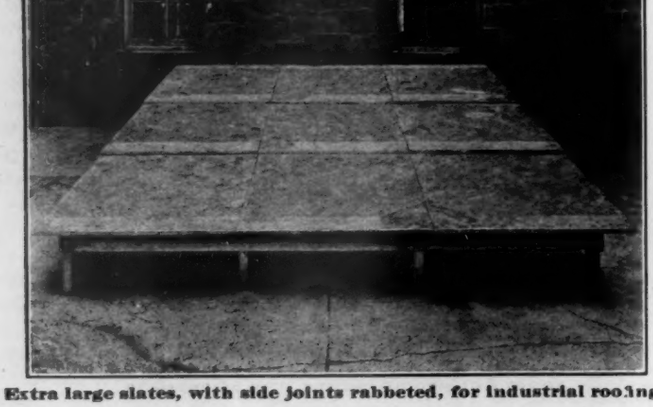
must be scrapped because it cannot be worked up into shingles or into any of the other commercial products. This incidental damage to the slate is due to the percussion of the power tools employed to make the 8- or 10-foot cuts just described—superior as these machines unquestionably are to the means previously used in our leading slate quarries.

The newest agency in this field of service is the wire saw. The wire saw is really not a saw as the term is generally understood: it is a 3-strand steel cable, usually about ¼-inch in diameter, that is spliced to form an endless cable that can be drawn taut and moved rapidly over the surface of the stone to be cut—the strands of the cable dragging along with them abrasive sand that actually does the cutting. This cable, hundreds of feet longer than the cut to be made, is driven by an electric motor that is mounted conveniently near the edge of the pit; and the running wire is carried thence on pulleys to the place or places in the rock where one or more cuts are to be made by the same cable and at the same time.

The abrasive sand is carried into the cut and to the traveling wire by suitably regulated streams of water; and the tiny granules of the sand provide the myriads of little teeth that wear away the slate at an astonishingly rapid rate, compared with the performances of other equipment. Instead of a cut having an average width of 2⅜ inches, made by a percussion machine, the wire saw will make a cut that is but a shade wider than the cable's diameter—virtually slicing the rock without the least violence and without injuring in the slightest the slate on either side of the cut so produced. In this way, in one Pennsylvania quarry, a cut 126½ feet long and 8 feet 6 inches deep was made in an operating period of 104 hours. It is quite common now in wire-saw-equipped quarries to make cuts at a rate of 20 square feet per hour. It is authoritatively stated that the wire saw will cut anywhere from two to four times as fast as the machines heretofore relied upon to do the cutting.

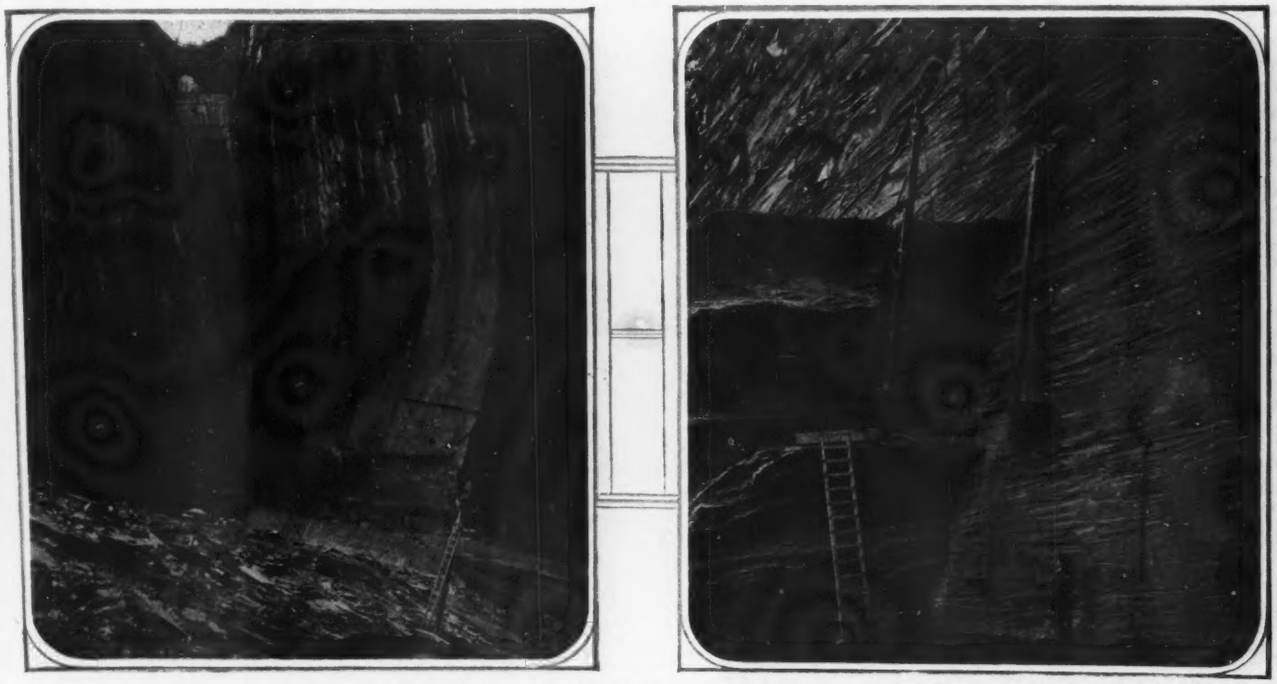
The wire saw, although generally but little known in America, has been doing good work in some quarries in Europe for fully 40 years. but it is believed that its use in slate quarries is a novelty. Its introduction there is due to Doctor Bowles' initiative and to the enterprise of certain Pennsylvania slate companies who provided the needful funds for the purchase abroad of a complete wire-saw equipment—the purpose being to ascertain by practical tests of a sufficiently comprehensive character how far the wire saw could be counted upon as a primary means of getting slate out of American quarries. As a consequence of those tests it became clear that the wire saw could be employed to great advantage in the Pennsylvania soft-vein region; and at one of the quarries there containing hard-vein slate a demonstration served to show the possible application of the wire saw to a still larger field of service.

As some of our illustrations make plain, the cable of the wire saw must be held taut against the stone to be cut; and the wheels guiding the wire through the rock are arranged so that they will maintain this tension and guide the wire in its descent. These wheels are mounted on stanchions or tension posts; and, by means of suitable gears, can be wound downward as needed. Where an open bench is available one of the tension posts can be suitably suspended over the face of the break, but the other will probably have to have a well or sink in which to set it up—this hole being a few inches deeper than the bottom of the cut to be made by the wire saw. The making of these holes has really been the principal reason for the slow adoption of the wire saw, because in the absence of special machinery the excavating of the holes is a tedious and a decidedly costly operation. The Belgians have developed a drum drill



Extra large slates, with side joints rabbeted, for industrial roofing.

Old English cleft type of random-width slates for domestic roofing.



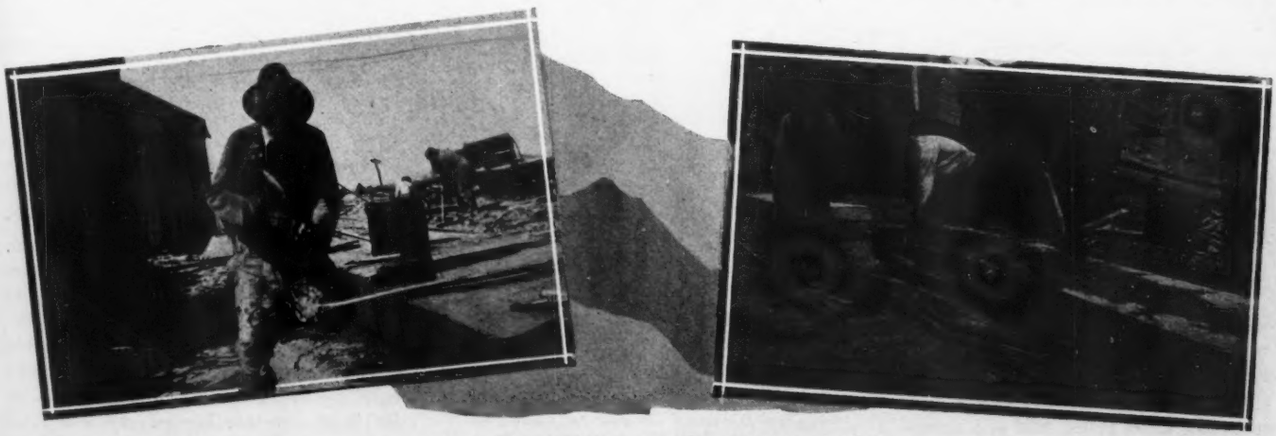
Left—Wire saw set-up in the 350-foot-deep Jackson Bangor Slate Company quarry. Right—Tension posts as set up over the break in the floor of the Chapman quarry.

capable of channeling an annular cut a meter in diameter—the core being removed afterwards. Such a drill was purchased with the original Belgian wire saw.

The machine did not prove satisfactory. It used sand as an abrasive agent; and the drum jammed when the drill was called upon to work perpendicularly to the more or less sharply slanting surface of the quarry bed. This inability to work at an angle showed that the drill would not be capable of undercutting the quarry walls—something that is indispensable in deep quarries where the maximum width of the quarry floor must be maintained lest the quarry grow narrower as it descends and thus leave untouched much valuable stone. To make a long story short, Americans have not only devised an improved wire-saw apparatus but they have also adapted a well-known type of core drill capable of excavating 36-inch holes and of operating successfully when working 30° from the vertical. We refer to the modified "Calyx" drill. The WS Calyx drill for this service was produced by the experts of the Ingersoll-Rand Company after a period of experimentation in certain of the Pennsylvania quarries. This drill is a rugged and, withal, a flexible machine especially designed for use in connection with the wire saw.

The WS Calyx drill is driven by a 15-hp. motor having ball bearings, and this motor is connected to a back-gear attachment which also has ball bearings. These ball bearings, besides necessitating a minimum of lubrication attention, permit the machine to stand and to work effectively on a slope of 30°—maintaining proper lubrication the while. This is needful owing to the fact that in many of the quarries the slate bed dips at a steep angle. The drive from the back-gear shaft is by means of a heavy roller chain to a countershaft near the middle of the machine, and from the countershaft another chain drives the spindle through bevel gearing. The spindle is of square steel so arranged that it can travel downward as it rotates and thus follow down the cut into the slate. The cutter consists of the regular Calyx shot bit, differing only in its unusual size. Sand is the abrasive used for the first two or three inches; but after the cut is started, chilled steel shot and water are dropped down into it to continue the abrasive action.

When a cut approximately 20 inches deep has been made, the depth depending upon the length of the drum or bit, the spindle and the cutter bit are hoisted clear of the quarry floor by a 2-legged derrick carried on a frame—the hoisting being done by means of a winch head mounted in the center of the countershaft. When clear of the rock, the spindle is unscrewed and the entire head is slid far enough back along the ways—provided for this purpose on top of the steel frame—to clear the bit, which can then be pushed either



Left—Breaking slate into blocks from which roofing slates are split. Right—Breaking large pieces of slate into sizes to be handled by the splitters.

to one side or lifted straight up as desired.

The core may be removed in several ways; but experience has shown that this can be effectively done by drilling a hole with a "Jackhamer" through the center of the core down to within a couple of inches of the bottom of the cut, and then by exploding a small charge of black powder at the bottom of the hole. The explosion will break the core off sharply at that depth; and then the detached core can be readily lifted out of the way. This procedure leaves an annular groove at the bottom of the cavity into which new steel shot can be dropped for the purpose of starting the second core cut. Thus, progressively, the work continues until a hole 10 or more feet deep has been excavated for the emplacement of a tension post. It is possible for the Calyx core drill to put down a hole 10 feet deep at the rate of 14 inches an hour!

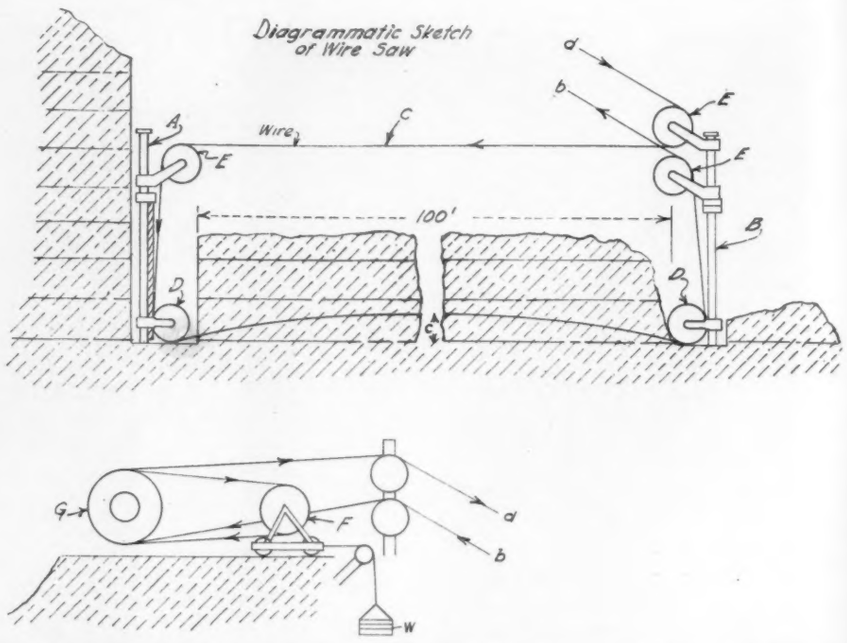
The development of the WS Calyx drill has placed the outlook for the wire saw upon an entirely new footing; and a goodly number of the big quarries in Lehigh and Northampton counties have provided themselves with wire saws and Calyx drills so that they may reap the fullest advantage of these new aids in getting out more sound stone faster and at a considerably lower cost than has been possible hitherto. The wire saws now in service have been devised by the Stroudsburg Engineering Works, Stroudsburg, Pa.

Wire-saw operators say that the saw can cut hard, segregated materials virtually as easily and speedily as slate, itself; and during one test a hard boulder from a West Virginia river was put under the wire while it was about to make a regular cut. The rock was severed without trouble. While making another cut a workman accidentally left a crowbar under the wire; and when he returned for the bar soon afterwards he found it severed!

A report issued by the United States Bureau of Mines sums up the virtues of the wire saw in this manner:

> "The saw requires one man only to operate it, and where a small air hoist is available not more than two men are necessary to move it from one set-up to another.
>
> There is little or no waste directly attributable to the saw cut except the actual rock cut away.
>
> The smooth surface left by the saw on the quarry blocks can be utilized to reduce preliminary mill sawing.
>
> The saw can be run 24 hours daily, if desired, without other than regular attendant labor.
>
> The development of the core drill has adequately solved the problem left open by the failure of the Belgian drum drill and thereby made the saw available for those quarries having no other means of opening sinks for the saw standards."

The Government experts also report that the tests made under their supervision revealed that the wire saw would cut anywhere from two to four times faster, and at a correspondingly lower cost, than the machines in use prior to the adoption of the wire saw. And we are informed that the cost of operating these familiar cutters is approximately at the rate of 68 cents per square foot of rock, while the wire saw will cut a square foot at a cost of 18 cents. No wonder the quarry operators of the Pennsylvania district in question are enthusiastic over the showings of the wire saw and the Calyx drill. These helpful agencies bid fair to give the quarries a new lease of life, and to place them in a position to meet the competition of less desirable manufactured products with natural products of outstanding and superior excellence.

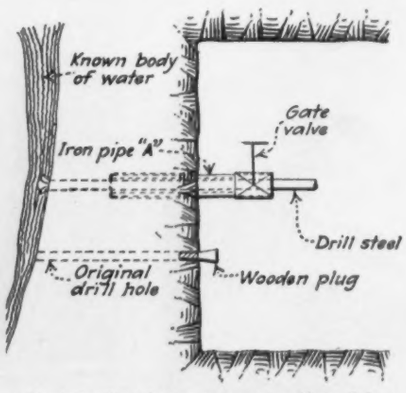


The wire-saw machine consists of two tension posts, A and B; a length of 3-strand wire, C; two adjustable sheaves, D; three guide sheaves, E; a tightening device, F; and a source of power, G. The leads of the wire to and from the source of power are indicated by b and d.

CHECKING WATER FLOW MET IN DRIVING HEADING

IN driving a heading in a lead mine in the southeastern part of Missouri, writes Roy H. Poston in the *Engineering and Mining Journal*, the drill tapped a body of water under such pressure that it would have given trouble if released before adequate means for the control of the flow had been provided. This was done effectually in a very simple manner, as shown in the accompanying sketch.

The original drill hole was plugged tightly, and then another and larger hole was started immediately above it. This hole was approximately one-half as deep as the first one. In this second hole a piece of wrought-iron pipe was firmly wedged and cemented; and to the outside end of the pipe was fitted a standard gate valve. After the cement had set the gate valve was opened, and a hole driven far enough through the cement to tap the water. This was done by inserting the drill steel in and through the gate valve and the pipe. Once the water was tapped the steel was withdrawn and the gate valve closed.



Sketch showing means employed to control flow of water struck in driving a heading.

REMOTE CONTROL OF LARGE ELECTRIC SUBSTATION

AN electric distributing station that will ultimately be able to supply power sufficient to light approximately 300,000 homes and that is operated without human guidance was put into service not long ago in New York City. This manless station is one of the largest of its kind in the world, and is controlled from a point three miles away.

By a system of dots and dashes, like those used in telegraphy, the operator in the distant control station is able to open and to close any switch in the new distributing station and thus, by means of electric impulses, to start and to stop transformers or to perform any of the required services. In turn, by means of automatic signals, he will be informed whether or not the far-away equipment is functioning properly.

Sand Blast Prime Aid in Modern Foundry

Many Kinds of Sand-Blasting Equipment Now Used In Cleaning Castings

By C. H. VIVIAN

PERHAPS Nature taught man the principle of the sand blast, for in many arid and semi-arid sections of the earth wind-blown sand and dust exert a scouring and abrasive action of such great effect as to constitute an erosive agency of importance.

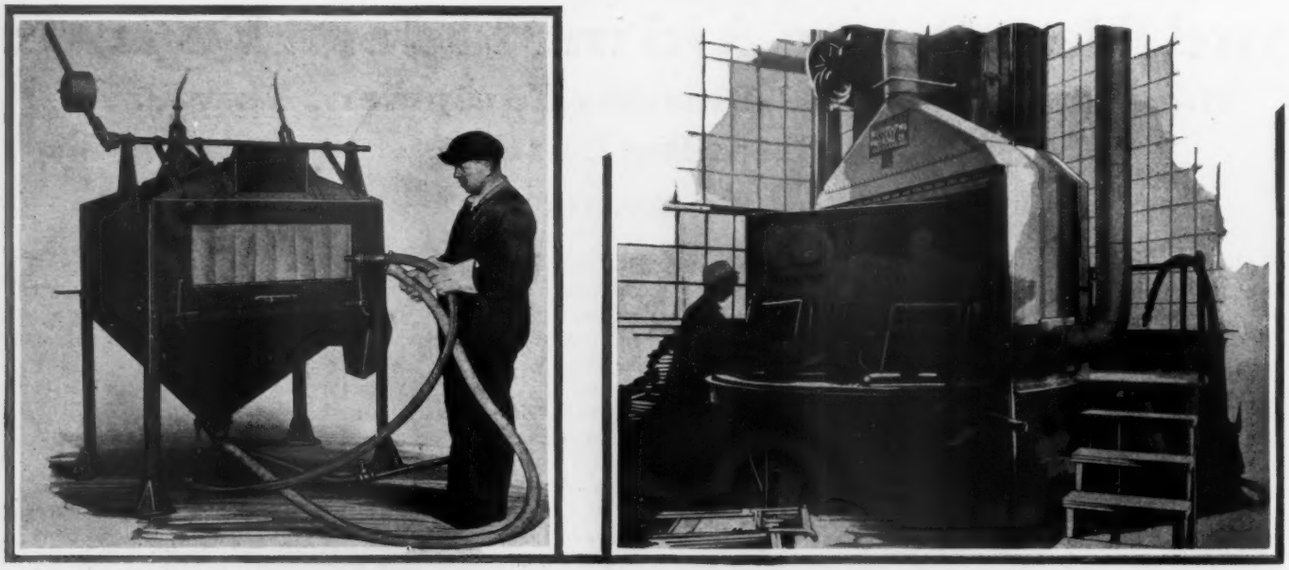
The sand blast merely reproduces and intensifies a natural phenomenon—setting up artificial conditions that can be directed and controlled as desired. By means of compressed air, the sand grains are hurled with many times the force of the strongest wind that blows. The effect can be modified at will by varying the volume and the character of the sand grains as well as the pressure and the cross section of the air current. Where the job is too rough for sand, it is accomplished instead by metallic fragments.

Thus the sand blast has been developed to the point where it is effective alike for the delicate operation of cleaning eggs for the market and for the removal of paint, grease, and scale from large metallic structures such as bridges and oil tanks, or for scouring buildings of brick or stone construction and restoring them to their original appearance. Between these two extremes is a middle ground in which it does its greatest amount of work. Its major field of use is in the foundry, where enormous quantities of castings are treated every day. As they come from the molds, castings of iron, steel, brass, bronze, aluminum, and other metals and their alloys, are coated with sand or fused sand and metal which must be quickly and thoroughly removed so that the articles can be further prepared for their ultimate purposes. The sand blast is the most effective and most economical medium available for doing this important work.

In many instances, castings require machining before they can be used. To machine them without removing sand and scale would impose ruinously severe service upon the cutting tools. The sand blast thus makes for economical and uninterrupted machine-shop work by prolonging the lives of these tools. A further saving results from the fact that the removal of the exterior coating exposes any flaws that may exist in a casting and permits its rejection before the expense of subsequent treatment has been incurred. An attractive appearance is sometimes essential and is always of advantage, and here, again, the sand blast accomplishes the desired result by producing a velvet-like surface. In short, castings that are sand blasted are generally recognized as superior to those that are not. This is attested to by the fact that they command a better price.

In the discussion of this subject, it should be borne in mind that foundry operations are of such proportions today as to constitute

An engraving on tapestry glass produced by sand-blasting. The 3-tone effect is obtained by varying the depth of the cut, the maximum depth being ¼ inch.



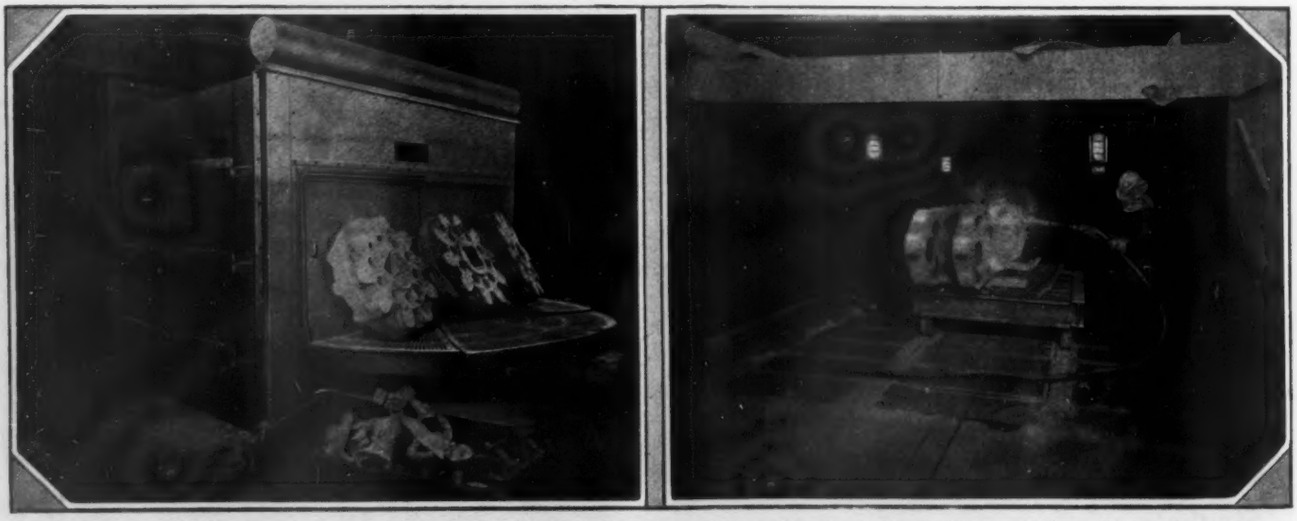
Left—A Sly hand cabinet. The operator is able to do his work intelligently by observing its progress through the opening at the top. Right—A Sly turntable installation. After the castings have been cleaned on one side the table is revolved so that the pieces can be turned over for cleaning on the other side.

one of the most important of all the fields of application of compressed air. While specific figures are not available, it is in all probability a fact that a greater total volume of air is compressed in the foundries of the world than in any other single branch where air is utilized. The aggregate capacities of the compressors installed in foundries run into millions of cubic feet per minute. Of this total, the larger share, of course, goes to operate the numerous pneumatic tools of various sorts that are indispensable in the cleaning of castings. Suffice it to say, however, that enormous quantities of compressed air enter into the process of sand-blasting.

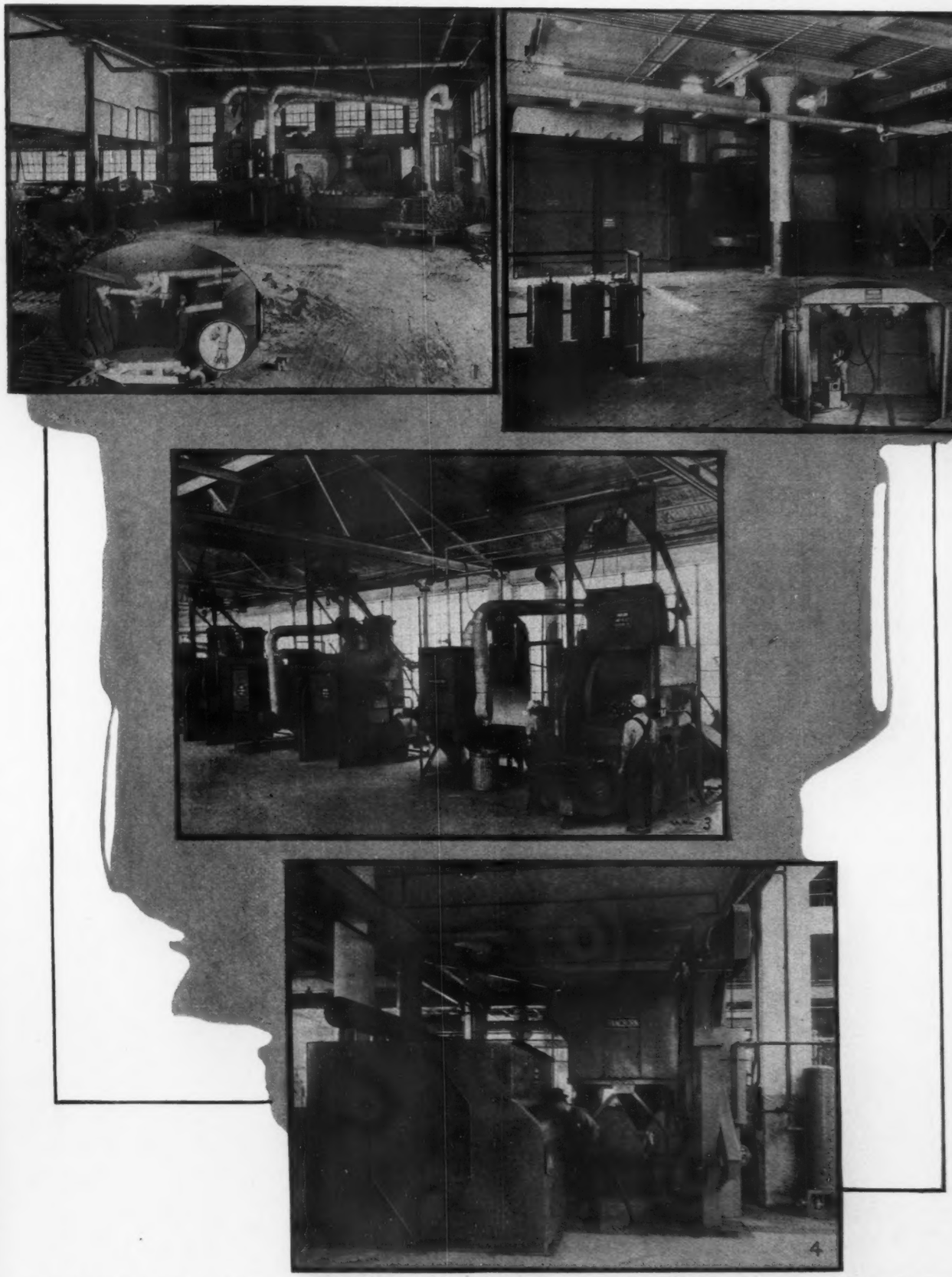
The extensive application of the sand blast to foundry practice has given rise to the development of equipment of various kinds. Where exceedingly large metallic pieces are treated, they are sometimes merely placed on the floor of the cleaning department and gone over by a sand blast in the hands of an operator. Smaller castings are ordinarily cleaned in rooms designed especially for the purpose and equipped to handle the articles in the quickest and most effective manner. The blast may, in such cases, be controlled and directed by an operator stationed either inside or outside of the cleaning enclosure, or it may be arranged so as to function mechanically. The method of treatment depends upon many variable factors, chief among them being the size and the character of the castings and the uses for which they are intended.

The present tendency is to make all operations continuous, or as nearly so as possible. Thus we find sand-blast tables in wide use. These are so built that one half of the table can be loaded or unloaded while pieces on the other half are being cleaned. This type of equipment can be varied in construction details so as to be suitable for the treatment of widely differing classes of products. For example, the table may be built flush with the ground level for handling large commodities, such as bathtubs, or it may be placed at a height convenient for the cleaning of smaller pieces. A modification of the turntable is the rotary table. In this the sand is automatically directed through overhead nozzles upon the articles to be cleaned and, in addition, the table that carries the pieces into the blasting compartment is automatically rotated.

Another type of machine that incorporates mechanical sand-blasting is the tilting mill. This combines tumbling and sand-blasting. The turning motion of the drum serves to bring each article to the top of the load at intervals so that it receives the full effect of the blast from the nozzle located at the elevated end of the barrel. Such mills are built in capacities up to 2,000 pounds of metal, and will clean a large tonnage in a day. A mechanical attachment for loading and unloading the barrel makes the action almost continuous, and reduces the handling of



Left—A Sly sand-blast room for handling medium-sized castings. By turning the table half a revolution the castings shown will be carried inside in position for cleaning. Right—Large pieces are loaded on a car and run into the sand-blast room on tracks. This picture of Sly equipment was made in a large power-shovel manufacturing plant.



Some of the sand-blast equipment made by the Pangborn Corporation. 1—A large, automatic, rotating sand-blast table. The sand supply for this machine is automatically renewed. Insert shows arrangement of the nozzles which direct the blast against the sides as well as the tops of the pieces being cleaned. 2—In this illustration are shown, from left to right, a sand-blast room, a gravity-type rotating table, and a dust arrester that discharges cleansed air into the room. Insert shows a sand blaster with a modern helmet. 3—A battery of sand-blast barrels with quick-loading devices. This type of barrel will handle twenty-seven 1-ton loads of average castings every nine hours. 4—A hygienic sand-blast room designed so that the operator works from the outside through a multiple-section rubber curtain. By means of a foot pedal the operator controls the rotation of the table inside the room.

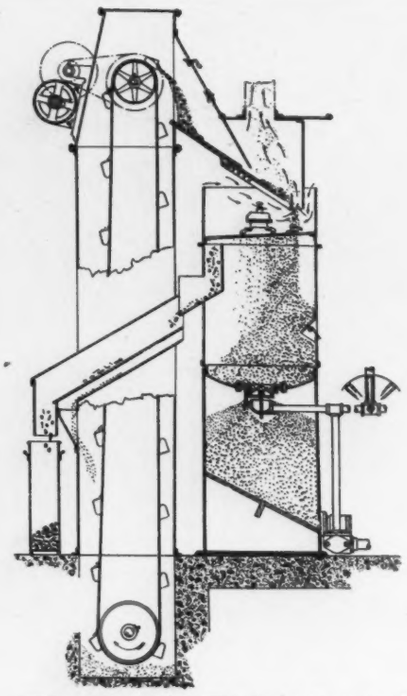
articles to a minimum. While these several types of equipment have their greatest use in the foundry, they also prove highly serviceable in treating forgings or any class of metal objects that requires thorough cleaning.

Much of the equipment of the sort described is fitted with suitable apparatus for reclaiming and reconditioning the sand so that it can be used over and over. From the article against which it is blown, the abrasive falls through gratings into a suitable container. From there it is elevated and returned to the tank which forms the source of supply for the blasting equipment. During its handling, a properly directed current of air carries off the fine material and leaves only the grains of sand that can be counted upon to exert the maximum abrasive effect. The sand-blast compartments are ventilated in such manner that the dust is removed as fast as it rises.

Admirably suited as sand is for cleaning by air blast, still there are conditions that favor the employment of steel particles as the active abrasive. This is notably true where metal surfaces are to be cleaned preparatory to receiving a coating of enamel. The following particulars on this subject have been furnished by a well-known manufacturer of sand-blasting apparatus.

When a casting is perfectly blasted for the best enameling results, its surface and appearance should be identical with a cross-section fracture of the casting, both in texture and in color. If the casting be not clean, opportunity for imperfect enameling is present, although it may not be realized. The abrasive used is the primary cause of such unexpected defects.

Blasting with sand produces a very light, grayish color. This white or gray color is not actually the surface of the casting but is a deposit of minute dust particles from the broken-down sand pounded into the pores of the casting. This "beautiful aluminum color", frequently sought, should be a monitor of possible poor results. As enamels are made from silica sand, there is an impression that the silica dust cannot or, at least, should not cause any trouble because that material is a component part of the enamel. If, however, the condition is analyzed, it should command serious consideration for two important reasons: first, the silica dust may conceal spots that are not perfectly clean and, second, the compounding of the silica content of the enamel with pigment and other ingredients is most exacting work. In other words, the surplus silica in the pores of a casting may not be taken up as it should be when firing the enamel. Thus, the extra silica constitutes a variable factor; and, besides, the blasting sand and the enamel sand may be entirely different.



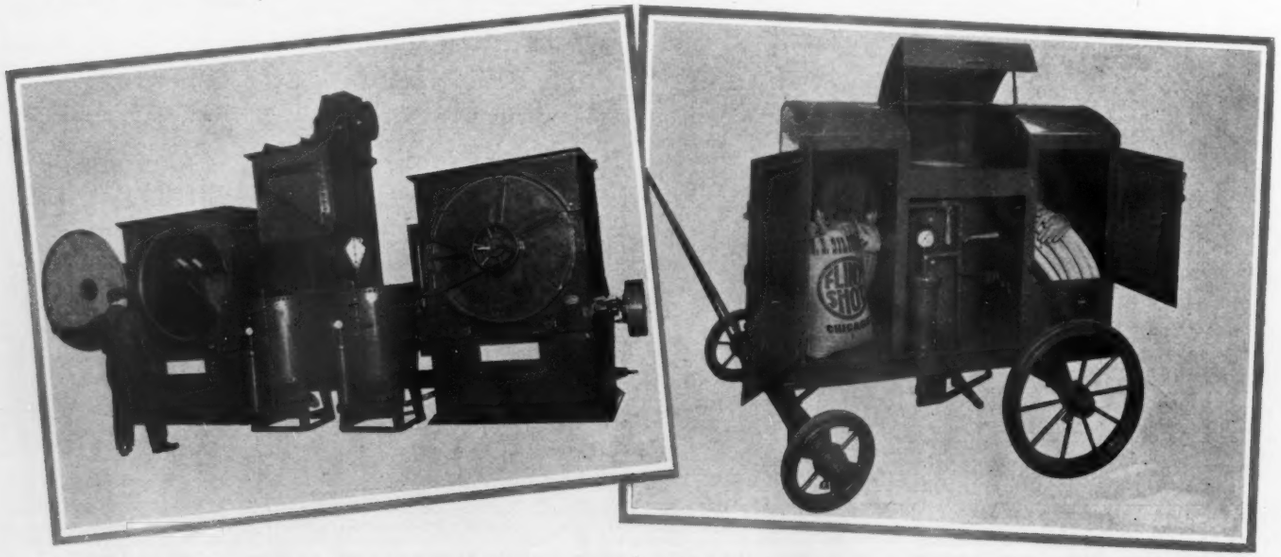
This cross section illustrates how used sand or other abrasives are cleaned of dust and metal particles in a reclaiming apparatus made by the Pangborn Corporation.

The opening of the pores of the metal by the sand is, of course, necessary. To accomplish this without concealing imperfectly cleaned spots with a deposit of coloring matter must be the aim of the enameler, otherwise he will not obtain a uniform surface, one that is thoroughly cleaned to the virgin metal. Steel abrasives will, of course, also open the pores of the metal and, perhaps, do the work even more effectually than sand on account of their greater specific gravity. There is no fracturing and breaking down, thus eliminating the fine dust that accompanies the use of sand. Furthermore, being themselves of metal, the color does not differ from that of the casting and, therefore, imperfectly cleaned spots are not apt to be concealed by them.

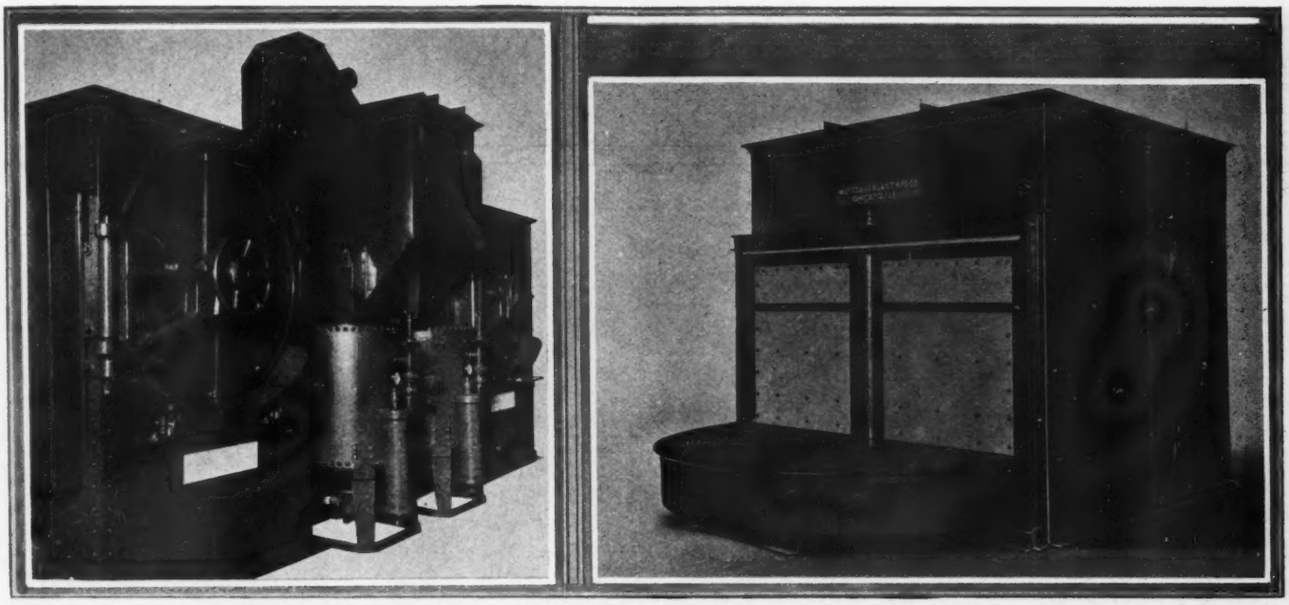
The more "raspy" or rough the casting the better the anchor for the enamel. This fact should be given due consideration in selecting the size of grits for blasting. The pores of such surfaces are open and clean, free from any deposits, and the casting is both physically and chemically clean to receive the enamel.

The nozzles generally used for sand-blasting have orifices or openings varying in diameter from $\frac{3}{16}$ inch to $\frac{1}{2}$ inch. The air pressures employed range from 30 pounds to 100 pounds, depending upon the composition of the article being cleaned. The maximum pressure needed for gray iron or malleable castings is 80 pounds, while in many cases 60 or even 30 pounds suffices. A minimum of 60 pounds is ordinarily required for effectively cleaning brass or aluminum, while steel castings call for not less than 90 pounds.

Factors controlling the amount of abrasive used are the size of the grains, the air pressure employed, and the size of the nozzle opening. For example, at 80 pounds air pressure a $\frac{3}{16}$-inch nozzle will use 500 pounds of 10-



Left—A Mott double sand-blast barrel with one of the doors open, showing how the nozzles are placed. Right—A Mott portable sand-blast outfit, showing compartments for shot, hose, etc. It is mounted on a steel frame, equipped with rubber-tired wheels, designed for easy towing by truck or automobile.



Left—A double sand-blast barrel made by the Mott Sand Blast Manufacturing Company. Right—In this Mott apparatus the turntable is built low to facilitate loading and unloading heavy pieces.

mesh sand per hour while a ½-inch nozzle, at the same pressure, will use 3,000 pounds of 5-mesh sand per hour. The volume of air consumed is governed by the air pressure that is maintained and by the size of the nozzle orifice. The following table gives the air consumption in cubic feet per minute for the nozzles and pressures in most general use:

Air Pressure In Lbs.	Air Consumption Cu. Ft. per Min. Diameter Nozzle Opening ¼"	5/16"	⅜"	½"
30	40	62	90	161
60	67	105	151	268
80	85	133	191	
100		161	231	

As a general proposition, the time that abrasive blasting saves over hand cleaning increases according to the complexity of construction of the article being cleaned. In the case of castings having numerous small openings that can be reached only with great difficulty by hand, the margin in favor of the sand blast is very pronounced. Figures quoted in *Compressed Air Data*, by W. L. Saunders, comparing the time required by hand and by sand blast for a number of types of work, indicate that sand-blasting is from two to ten times as efficient as are hand methods of cleaning.

Successful tests are announced by the Canadian Pacific Railway of a method developed by that road for increasing the smoothness of railway travel and for lengthening the life of the rails. By the method, the dips or hollows at the points where the rails connect are fused by electric arc welding. This melts the rail to a depth of one-eighth of an inch and fuses thereon a deposit of 5 per cent nickel steel, which is nearly 50 per cent harder than the rail itself.

PNEUMATIC PIPE-BENDING MACHINE

THE machine in the accompanying illustration is a pipe bender which is both portable and adjustable, permitting the forming of bends of any desired length and arc within its limits. The piece of piping to be shaped is laid on two steel spools, the distance between which can be regulated by putting them in notches cut in the 4-foot cross frame consisting of parallel steel plates placed 6 inches apart. Set in the top of the main framework is a 12x14-inch air cylinder that is connected with the shop air line by a hose. When not in use this hose is rolled up and hung on two large hooks at the back of the machine. The pressure is regulated by a small 2-way valve, and is applied to the pipe through any one of several different-sized semi-circular heads which are held to the lower end of the piston by a key. These heads are grooved to fit the contours of the pipes.

Portable air-operated pipe bender. This machine can be adjusted to form bends of different lengths and arcs.

One man can easily move the machine from place to place; and by its use it has been possible, it is said, to cut the time to do the work to about half that formerly required.

COMPRESSED AIR DISTRIBUTES OIL IN GARAGE

COMPRESSED air helps to save the day in many instances because of the facility with which it can be applied and the ease with which it can be controlled. For example, in the main garage of the Auto Interurban Company, of Spokane, Wash., the lubricating oil for the establishment had to be stored where it could not be reached conveniently at the points of use. The plant layout is such that the crankcase changes are made on a floor slightly above the street level, while the heavy repairs are made on a floor beneath where the oil tanks are located.

The situation was taken care of, says the superintendent of equipment, by providing four 65-gallon tanks and by running as many 1½-inch pipes, terminating in faucets, up to the inspection floor. The lubricant is kept under pressure, thus assuring a steady flow the moment one of the faucets is opened—the level of the oil in each container being indicated by a 24-inch glass tube. The air is admitted at the top of each tank through a ¼-inch line, and the pressure is regulated by a valve set at 35 pounds. The system not only lifts the oil vertically a matter of 16 feet but carries it horizontally a distance of 12 feet. The entire installation has cost about $175. At the present time only two of the tanks are in use, the others being in reserve.

RUBBER BINDER FOR FOUNDRY CORES

SAND cores in the foundry have played a very important part in the development of the art of molding and in the reduction of molding costs. There still remain, however, some phases of present-day foundry-core practice that may be improved upon.

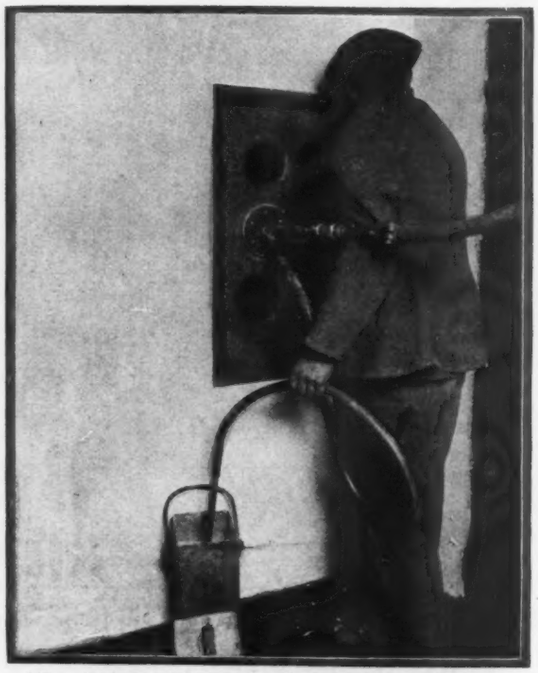
Cores as generally used at the present time owe their strength or coherence to binding materials and to baking. Strength, however, is required only before casting, and easy disintegration of the sand core is very desirable after the cast metal has solidified around it.

The removal of cores from castings is often an expensive, laborious, and dusty task. Cracked castings due to hard cores which do not crush as the metal solidifies, and core blows due to low permeability of the cores, are sources of foundry losses.

Recently there has been developed at the United States Bureau of Standards a new core-sand binder of which rubber or some allied material forms the base. The outstanding advantages claimed for this binder are: The cores crush readily, falling of their own accord to loose sand that may be poured from a casting instead of having to be dug out of it. The cores have greater strength than those of green sand and extend the range of jobs to which a readily crushed core may be applied. The cores are not oven baked: they are merely air dried. The cores are of high permeability and show remarkable freedom from blowing.

The new core binder consists, essentially, of a solution of unvulcanized rubber in gasoline. The amount and the kind of rubber binder used in making cores depend upon the type of core sand, the size of the core, and the metal to be cast around it. A core strength equivalent to that of a green-sand core or a baked oil-sand core can be attained by the rubber binder which has proved to be successful in producing cores for castings of lead, tin, zinc, brass, phos-bronze, bronze, aluminum, iron and steel.

With the completion of the Sarda Canal late last year in northern India there was formally opened to service what is said to be the world's greatest irrigation system. About 4,000 miles of distributing channels are included in the system, which will make productive a vast area covering more than 7,000,000 acres.



The air-operated gun forcing soapstone through a 400-foot conduit.

AIR GUN SHOOTS SOAPSTONE THROUGH CABLE DUCTS

ORDINARILY, when the alert city dweller sees a portable alongside the curb throbbing away at its job of producing compressed air, he begins to look around for paving breakers or kindred pneumatic tools today extensively employed in street repair work. Nowadays, however, portable compressors supply air for other purposes in our busy thoroughfares, such, for example, as removing obstructions in service gas mains and in preparing underground conduits for their electric cables. The use of compressed air in the latter field is apparently novel, and has been introduced in New York City by The New York Edison Company.

Electric ducts must be clean and well lubricated before they can receive their cables; and for this work the company in question now equips its men with a portable compressor, wooden mandrels, flexible rubber-lined plungers, a pneumatic soapstone gun, and articulated brushes. These are employed variously in testing the clearance of the conduits, in removing large obstructions, in applying soapstone, and in cleaning the passageways of loose sand and pebbles that might injure the cables.

The air-operated soapstone gun, in which we are primarily interested, consists of a piece of ¾-inch tubing, 3 feet long, terminating in a ½-inch "Y" connection to which are attached two lines of hose. One of these is a high-pressure air line that taps the compressed-air tank on the portable, while the other serves to feed the soapstone to the gun. A metal disk stopper, thickly padded with felt, is fitted at the joint of the pipe and "Y" connection, and this seals the duct at the delivery end when the gun is in operation At the opposite or discharge end a loose plug is utilized for the same purpose. By intermittently inserting and removing this plug, the pressure within the conduit can be built up or lowered at will, thus agitating the soapstone and assuring satisfactory distribution. In this way the inner surface is lubricated throughout so as to reduce the friction encountered by the cable during its passage through the duct.

By means of this high-pressure soapstone gun it is possible, at one operation, to lubricate conduits having an average length of 400 feet. In the case of ducts 500 feet and over it has been found expedient to force the soapstone through from both ends. Approximately 15 pounds have been used for each 100 lineal feet of duct; and the time required to clean and to lubricate a conduit of average length has been about ten minutes.

Photos, Courtesy New York Edison Company

The portable compressor and the pneumatic soapstone gun used in cleaning and lubricating electric-cable ducts.

Niagara Falls, N. Y., claims that it is the most completely electrified community in the United States, if not in the world. Only 22 houses within the city limits are not wired. When these old structures are replaced, as they will be before long, by modern buildings, then Niagara Falls will be 100 per cent electrified.

Fighting Flaming Oil Wells at Santa Fe Springs

High-Pressure Gas Has Caused Two Costly Fires in This Very Productive California Field

By A. S. TAYLOR

IMAGINE a roaring torch with a flame 180 feet high and you get an idea of the sizzling spectacle that dominated the oil field of Santa Fe Springs, Calif., during most of last November. As long as it continued to burn it was a menace to neighboring properties; and until that flame was snuffed out it consumed, so it has been estimated, something like 4,000 barrels of petroleum and between 5,000,000 and 10,000,000 cubic feet of gas every 24 hours.

Besides wrecking the derrick that had stood over the well—turning the steelwork into a crumpled, fused mass of metal, the intense heat of the thunderous torch either damaged directly or necessitated the destruction and abandonment of near-by derricks and other equipment in order to prevent the spread of the fire and the possibility of a still greater catastrophe.

It is well-nigh impossible to convey an adequate idea of the magnitude and the withering heat of such a torch. The noisy reverberation of the flame was deafening, and could be likened only to the simultaneous blast of the safety valves of a score or more of giant locomotives. On the windward side of the flame, in the protecting sweep of air streams set in motion by airplane propellers driven by airplane engines mounted on trucks strategically placed, the heat was hot enough at a distance of 100 feet to singe the hair on one's bare hands. The surrounding ground was baked, and the surface nearly as hot as the top of a stove. Men could approach the projecting top of the casing only when garbed in asbestos and further shielded by streams of water played upon them. Bulwarks or breastworks of earth, thrown up around the well, served as a potential defense against any oil that might flood the area; and barricades of sheet iron were erected as a cover for the fire fighters and as a partial protection to some of the standing derricks, tanks, and other equipment. The scene was, indeed, a battle ground. The hazards were numerous; and no one could foretell when and how they would break loose.

The Bell View gasser blew in out of control on November 8, and took fire immediately either from the chance spark of friction or contact with the fire under some of the boilers in the vicinity. The towering flame was not snuffed out until the last day of November. That climax to nearly two weeks of desperate work quenched a beacon that had been visible nightly for many miles and had served as a guide the while to mail-carrying air pilots heading for Los Angeles.

The Bell View fire was the second outburst of the sort in the Santa Fe field, and further confirmed the existence of another high-pressure gas zone in the underlying sands—bringing the total up to four zones and emphasizing the need of great caution in penetrating these areas lest additional wells blow in out of control and entail extravagantly costly losses. Prompt action and a measure of good luck saved some three or four other wells from running riot, so to speak. The first evidence of the fire hazard due to high-pressure gas appeared when George F.

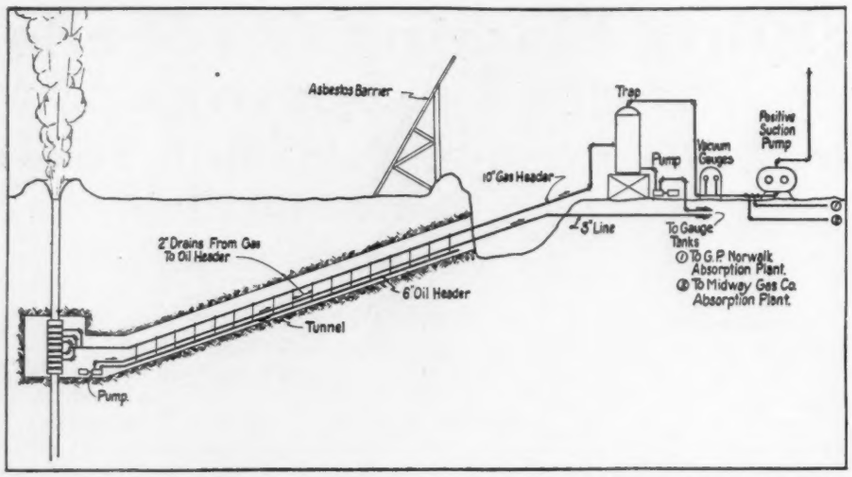
Top, left—Firemen making connections to fight the flaming Bell View well. Right—The entrance to the tunnel leading down to the casing of the Bell View well more than 200 feet away. Center—Airplane engines, mounted on trucks, used to blow streams of cooler air toward the flaming well so that workers could get close to the roaring torch. Bottom, left—Portable air compressors that furnished motive air for the clay diggers used in driving the tunnel. Right—Tractor serving as a hoisting engine to pull loaded muck cars out of the tunnel.

Getty's Nordstrum No. 17 blew in out of control on September 16—the escaping gas being well-nigh instantly ignited when the spreading gas reached the fire bed of a neighboring boiler. At the start, the flame was fed with 25,000,000 cubic feet of gas and about 5,000 barrels of oil; and for substantially seven weeks the torch burned menacingly.

In a short while after the conflagration started, the steel rig over the well was wrecked, and a number of near-by wooden rigs were destroyed. All told, five steel rigs and an equal number of wooden ones were torn down or blown to bits with dynamite to minimize the likelihood of the fire spreading. Something like 40 strings of tools ceased working on other wells lying within the danger zone. What was done finally to quench the flame at Getty's Nordstrum No. 17 should be mentioned so that we can understand the procedure adopted in the case of the Bell View well.

After all other efforts had failed, it was decided to drive a sloping tunnel 240 feet long so as to reach the casing of the well at a point about 50 feet below the ground surface. The tunnel was driven from a pit—the excavated earth being banked up on the side nearest the blaze and serving as additional support to an asbestos shield 30 feet high and 70 feet long. Equipped with air-driven clay diggers—the air being furnished by two 7x6-inch portable compressors, the men began their toilsome and risky work of tunneling. Each crew consisted of two diggers, two muckers, and two timbermen; and each crew labored only for half an hour at a time.

In section, when timbered, the tunnel was 4 feet wide and 5 feet high, and sloped at an angle of approximately 15 degrees. The purpose of tunneling was to tap the piping of the well and to by-pass the oil and gas through other pipes passing rearward through the tunnel—thus reducing the fuel to the flame sufficiently to permit snuffing it by covering it with a metal cone. The method employed in tapping the well casing is similar to that in common use in tapping high-pressure gas and water mains in municipal systems.



Courtesy, "Doings in General"

Method employed in taking oil and gas from Getty's Nordstrum No. 17 well.

In the case of Getty's No. 17, there were three strings of pipe in the hole, ranging from 16 inches in diameter to 9 inches in diameter, and all these had to be tapped in making the connections that were to carry the fuel away from below the flame. This fuel was, in the main, gas, and this was drawn off through four 3-inch lead pipes—several XB compressors being used to withdraw the gas at a sufficient rate to reduce the torch above ground to a relatively modest flame that could be snuffed out with a cone lowered into position by a caterpillar derrick. The driving of the tunnel and the completion of the difficult work called for substantially 28 days of continuous effort. The work on Getty's Nordstrum No. 17 was carried on under the direction of the General Petroleum Company, and the tunneling was finally carried out successfully by the Robinson-Roberts Company, engineers and contractors of Los Angeles.

With the experience gained in dealing with Getty's No. 17, the blowing in out of control of the Bell View high-pressure gasser presented nothing new as a fire-fighting problem. The destructive violence of the flame was disturbing only for a relatively brief period, during which neighboring property owners got together and guaranteed the funds necessary to carry on the battle with the ignited wildcat. It

Photos, The Inman Company

Left—Fifty feet underground, caiking a joint in an oil-well casing exposed in the working chamber at the bottom of a sloping tunnel. Right—What happens when an oil well, blown in out of control because of high-pressure gas, becomes ignited.

1—Asbestos-cloaked pipe men working at the top of the Bell View well. 2—Some of the metal shields erected to protect neighboring properties from the scorching heat. 3—Great torch of the flaming Bell View well as it appeared shortly before it was snuffed out. 4—Part of the area devastated by the ignition of the Bell View well. 5—Sprays of water were played continually on some properties as long as they were menaced by the heat of the burning well.

was decided that the best way to proceed would be to drive a slanting tunnel from the closest practicable point so as to reach the well casing substantially 50 feet below the ground surface and to tap the casing, as was done at Getty's No. 17. This would make it possible greatly to diminish the flow of fuel to the flame and thus to reduce the size and fierceness of the torch to a degree that would permit it to be snuffed out by covering it with a suitable metal cone.

Left—Flaming torch of the Bell View well as seen from a comfortable distance. Top—A bit of the subtropical setting of the Santa Fe Springs oil field. Bottom—Part of the smoking, heated area surrounding the flaming Bell View well.

Theoretically, this was simple enough but no one could tell whether or not the well was burning underground nor what grave risks would be run in approaching the casing or in tapping it. However, these risks had to be run; and the best that could be done was to minimize them by taking every precaution likely to safeguard the workers. Operations were generally supervised by C. W. Eckles, of the Union Oil Company; and the driving of the tunnel was awarded to the Robinson-Roberts Company who had done similar work on the previous blaze. The tunneling was done under the immediate direction of C. L. Roberts of the company mentioned.

As has been stated earlier, the Bell View well blew in out of control and became ignited on November 8, but it was not until eleven days later that the ground could be cleared and preparations completed for the subterranean attack. Prior to this, a "Christmas tree"—a type of valve assembly familiar to oilmen—was placed on top of the casing. This provided an additional vertical length of smaller piping which raised the bottom of the torch that much higher above the ground. This Christmas tree was put in position by a power-shovel boom that was covered with asbestos and upon which streams of water were played as it approached the flaming well. It was a ticklish and a distressingly hot job.

Operations were begun by excavating a pit 45 feet deep and 20x30 feet in cross section. This pit permitted starting the tunnel portal at a point well below the ground level so that it could be continued on an easy slope that would intercept the well casing a little more than 200 feet away. The tunnel was driven through a sand-and-clay formation that had to be timbered from end to end. When timbered, the passage was 4 feet 6 inches wide and 6 feet 6 inches high in the clear.

The digging was done with No. 57 I-R clay diggers; and air to operate these tools was furnished by two 7x6-inch Type 20 portables that were hooked together. The men worked in crews of six and for very short periods because of the heat and the strenuous character of their task. Each crew—made up of two muckers, two miners, and two timbermen—was expected to show to its credit an advance of 6 feet during an 8-hour shift. The muckers received $7 a day, while the miners and timbermen were paid $9 a day; and as an incentive to speedier advance a crew was paid a bonus of $1.50 for each additional foot of progress. As a matter of fact, some of the crews drove as much as 15 feet during an 8-hour shift. An average of 25 feet of linear advance was made every 24 hours.

When the 16-inch casing was uncovered at the inner end of the tunnel, a working chamber was excavated 14x14x12 feet in the clear—that is, inside of the heavy timbering. This chamber was necessary to provide ample room in fitting the valves and in cutting through the casing. Happily, the tunnel was driven without a single serious accident; and the excavating was done and the pipe-tapping apparatus fitted upon the casing in the record time of eleven days. The purpose of the contractor was to tap the 16-inch casing and to grout the space between it and the next or 11-inch pipe, and then to tap the 11-inch pipe and to grout the space between it and the inner or 7-inch oil string. A connection was to be made with the 7-inch pipe after it was tapped, and the oil and gas then to be led upward through the tunnel to the outlying pit where pumps were to be installed to pick them up and to convey them to suitable tanks located beyond the danger zone of the burning well.

Before Mr. Roberts and his men completed the connections underground, the fire fighters at the surface made one more effort to snuff out the flame at the mouth of the

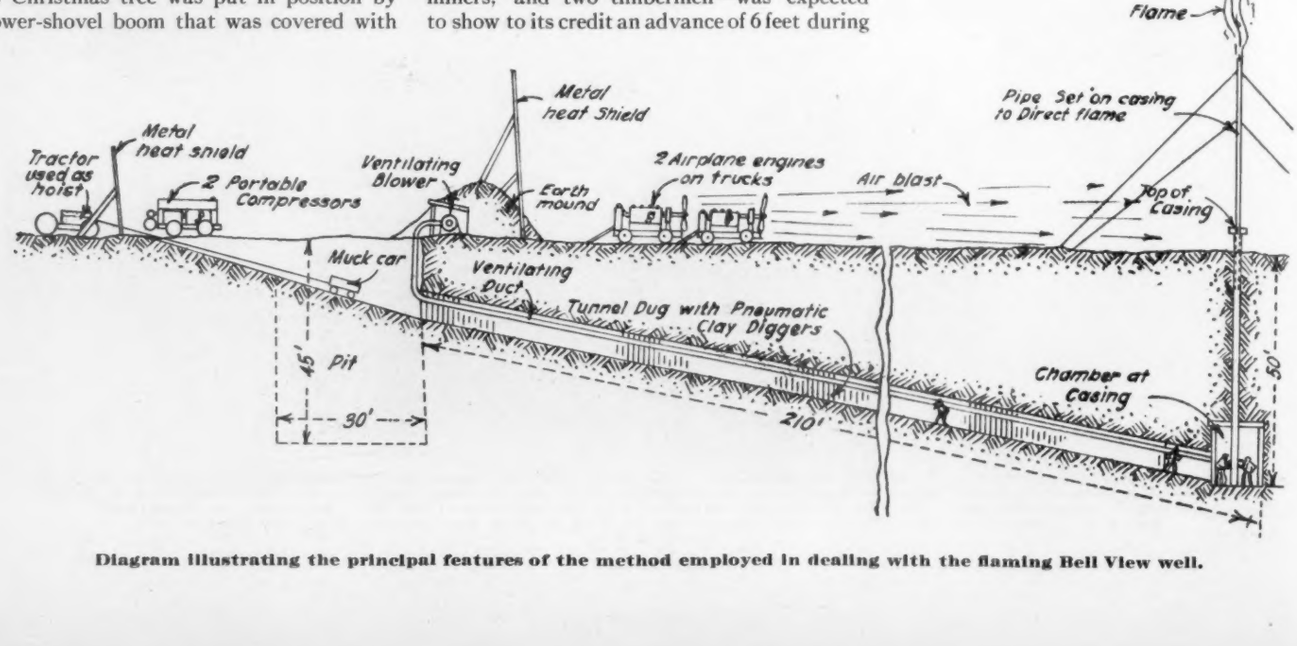


Diagram illustrating the principal features of the method employed in dealing with the flaming Bell View well.

well. They succeeded despite the hazards confronting them—including the risk of being blown to bits or burned to a crisp before any aid could be rendered them. The valve assembly that had been placed on top of the casing was held there only by its weight and the fact that the attached open pipe furnished a free vent for the gas and oil that fed the flame; and the object was to weld the Christmas tree to the casing so that the valve could be closed and the blaze extinguished by cutting off its fuel.

To do this, men wearing asbestos suits crept toward the well while airplane propellers sent a blast in their direction strong enough to blow the flaming torch sidewise and to sweep much of its radiant heat away from the men. As the workers got nearer the well, firemen kept them covered with streams of water. Thus shielded, a boss mechanic and his welders got busy. First, the Christmas tree was secured to the well casing with two clamps that were screwed tight with long wrenches, and then the welders, with electric welding arcs, set about making the union a perfect one. Just how perilous that work was can be realized when it is learned that the boss mechanic was paid $1,500 and each welder $500 for their brief toying with sudden death.

With the clamps in place and the welding finished, then came the crucial moment. It was the job of the boss mechanic to close the valve on the Christmas tree and to shut off the supply of oil and gas to the torch that had roared its defiance for 22 days. If the welding and the clamps failed to hold or proved weak at any point, there was the hazard of a sheet of flame shooting out sidewise with possibly appalling results. It took an amazing amount of courage to stand there and to manipulate that valve; and the persons watching the operation did so with bated breath and hammering hearts. Fortunately, the clamps and the welding withstood the test, and the flame of the Bell View gasser petered out and was silenced.

During the eleven days that tunneling operations were pushed, a total of 100 men took their turns in carrying the work forward; and the cost of putting out the fire was in the neighborhood of $25,000. This sum does not include any of the losses sustained by surrounding well owners who were forced to wreck some of their equipment and to cease their operations during the period of the fire. At the present time Santa Fe Springs is producing 100,000 barrels of oil a day; and this fact makes clear the possible economic loss that may follow from a widespread fire in that field where the gas pressures are exceptionally high and hard to handle.

The air-driven clay digger made it possible to do the tunneling at a rapid rate.

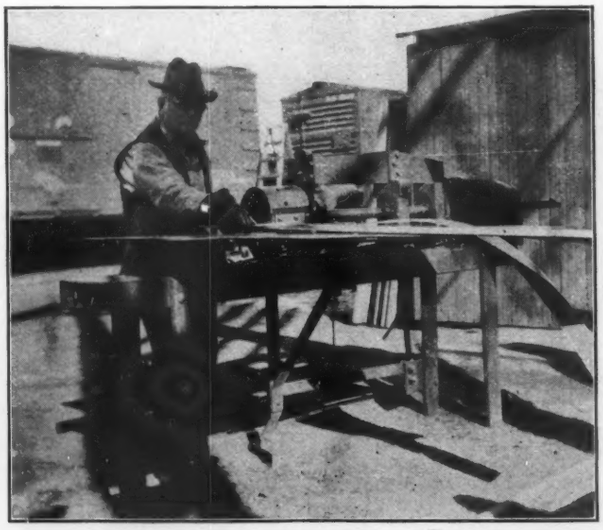
The man that buys his motive gasoline or his lubricating oil at the handiest service station may ponder a while upon the risks run in tapping the primary sources of these supplies—supplies that the average person accepts as a matter of course.

AIR-OPERATED MACHINE CUTS SHEET METAL

UNEXPECTED jobs are always turning up in and about large industrial plants, and these sometimes necessitate the use of equipment that is not immediately available. That is just what happened not long ago in the Denver, Colo., shops of the Union Pacific Railway during the rebuilding of a goodly number of freight cars.

For this work a large quantity of sheet metal had to be cut outside of the shops, and to do this with dispatch a motor-driven cutting machine was devised. A Size A air motor, with a mandrel about 4 feet long, was mounted on a steel bench. At the extreme end of the mandrel two disks, each ½ inch thick and 4 inches in diameter, were adjusted so that the sheets of metal, passing between them, were sheared by the square edges of the disks. One of these was secured on the live mandrel, the other on an idler; and both were covered with guards for the protection of the operator.

In order to cut down the speed of the motor so that the metal sheets could be properly manipulated by hand during their progress on the cutting table, a small brass plate containing a 1/16-inch orifice was placed inside a nut-and-swivel union in the air line. Compressed air for the operation of the machine was drawn from the shop's main air line.



Courtesy, Rai way Mechanical Engineer

Cutting sheets of metal with an improvised air-operated machine.

SUGAR FROM WOOD

DR. Friedrich Bergius, best known for his classical work in connection with the liquefaction of coal, has developed, after years of research, a chemical process for the conversion of wood into sugar. Wood in the form of dried sawdust is leached with concentrated hydrochloric acid in diffusion cells after the manner employed in the beet-sugar industry, producing a syrup of high acidity. The acid is removed and recovered by mixing the solution with hot oil in a vacuum and by absorbing the gaseous acid in water. The deacidified syrup contains about 2 per cent of hydrochloric acid, but this can be neutralized with lime and the syrup concentrated or evaporated to dryness for use as a carbohydrate addition to stock feeds. Doctor Bergius has thus obtained from wood a yield of 65 per cent of digestible carbohydrate. If further refined for human consumption a loss of an additional 25 per cent is sustained. The resultant sugars are said to be neither dextrose nor sucrose but to lie somewhere between starch and dextrose.

A monster 50,000-watt lamp, having the appearance of a radio tube, has recently been built for experimental purposes. A radiator of metal fins on top of the bulb carries off the intense heat generated by the white-hot tungsten filament, which has a temperature of 5,500° F.—twice as hot as molten steel. The lamp is filled with nitrogen. The circulation of this gas cools the lamp and takes with it up into the radiator any particles of tungsten thrown off from the filament, thus preventing the blackening of the glass walls. Huge lamps of this type may ultimately be used for the lighting of airports and motion-picture studios.

New Self-Contained Refrigerator Truck

BEFORE the introduction of the refrigerator car, about half a century ago, railroads were used but little for the transportation of perishable commodities. Meat was moved from place to place "on the hoof", or else it was cured so that it could be shipped as ordinary freight. Those were the days when every butcher had to do his own slaughtering—when the nationwide, wholesale distribution of fresh meat, fish, vegetables, fruit, etc., as we know it today, was unheard of. Eggs generally were a "home" product; and the banana, instead of being the common article of foodstuff that it now is, especially in the United States, was a curiosity any distance away from the equator. But it is not the refrigerator car, itself, that interests us at present: our chief concern is to tell what has been done to supplement or to extend cold-storage traffic by the aid of special motor trucks designed to carry perishable commodities of all kinds.

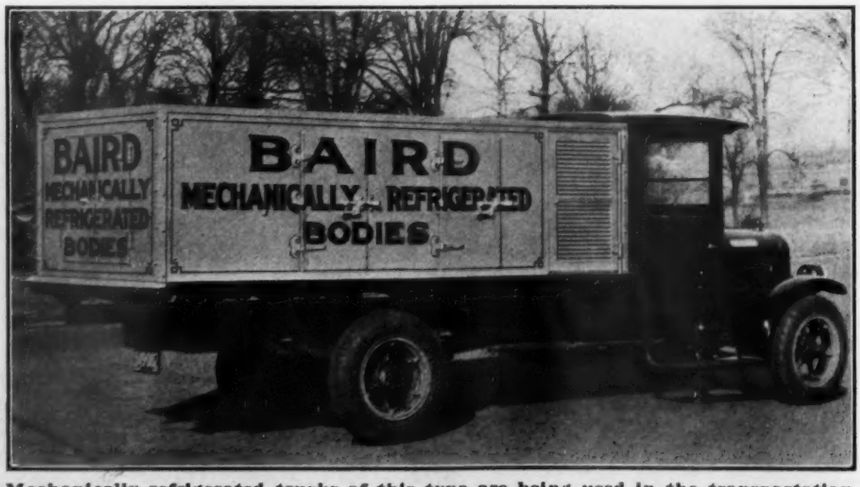
Forward compartment of one of the Baird refrigerator trucks showing the ½-ton compressor.

Some of the first of these were ice-and-salt refrigerated trucks constructed on the lines of the refrigerator car, and were not always practical for a number of reasons. To offset these there has been built and put in use a mechanically refrigerated motor truck that is intended primarily for short hauls and to take up the transportation of cold-storage comestibles where the refrigerator car leaves off. This is a logical step forward in the distribution of perishable foodstuffs.

Trucks of this type make it possible, so it is claimed, to save considerable time and money on shipments between near-by cities—such, for example, as New York and Boston; and they facilitate the movement of less than carload lots. In evidence of this is cited the service already being rendered in this field by the ordinary motor truck that is really not suitable for the purpose. Not being refrigerated, there is always the danger of the goods spoiling in transit, especially in the summer months: and that explains why the runs are so often made during the cooler hours of the night.

Motor trucks properly refrigerated lend themselves readily to the haulage of all sorts of comestibles from the centrally located cold-storage house of the wholesaler to the retailer who, not infrequently, is a hundred and more miles removed from the source of supply. In this way, beef can be delivered to him in prime condition; and the most delicate fruits will arrive as fresh and juicy as they were when picked. Small self-contained motor trucks of this type are a great improvement over the familiar "traveling markets" that go from house to house in outlying districts selling meat, fish, vegetables, and the like, to housewives.

A mechanically refrigerated body designed so that it can be mounted on any standard truck chassis has been produced by the William F. Baird Company, of Winchester, Mass. The machinery consists of three essential parts: an electric generator, secured to the chassis, that is driven through the power take-off on the transmission; an electric motor that receives current from the generator and drives the refrigerating unit; and a ½-ton air-cooled, direct-expansion methyl-chloride compressor. The equipment—including generator, motor, and refrigerating coils—weighs only 760 pounds.



Mechanically refrigerated trucks of this type are being used in the transportation of ice cream.

While underway, or when parked with the engine running, power for the compressor is drawn from the truck motor through the medium of the generator—the demand being at no time such as to affect the operation of the truck. The output of the generator is controlled by a voltage regulator—current at 110 volts being maintained with a speed variation of from 5 to 30 miles per hour. If it is necessary to park the truck overnight, power for refrigeration may be obtained by plugging into any convenient electric outlet.

The body of the Baird truck is well insulated with cork board; and, under ordinary circumstances, the refrigerating machinery does not have to be run more than a few minutes every hour. As soon as the temperature in the cold-storage compartments rises to a predetermined limit, then an automatic thermostat starts the electric motor and again stops it when the desired minimum is reached. The trucks are designed to meet different requirements and range in size from the large vans, for bulk transportation, to the type suitable for the delivery of foodstuffs from the cold-storage warehouse to the retailer or for the use of the itinerant dealer in meats, produce, and other perishable commodities.

PRESSURE FILTER DEWATERS COLORIMETER SAMPLES

AT the Copper Queen concentrator of the Phelps Dodge Corporation a simple and effective pressure filter is being used in the colorimeter method of assaying. This filter consists of a 9-inch pipe, 14 inches long, set vertically on four legs. A top lid and a bottom plate, hinged, have gasket insets and are brought into place and held by cam levers. This arrangement does away with nuts and threads. The bottom plate is perforated with $\frac{3}{16}$-inch holes on $\frac{5}{8}$-inch centers.

To filter a sample, a piece of canvas and a piece of filter paper are put on the bottom plate, which is brought up to the bottom of a cylinder and tightened with its cam lever. Next the sample is poured into the cylinder and the top cover made tight in a like manner. Air pressure is admitted at the side of the cylinder. This method of dewatering samples greatly facilitates colorimeter determination and assures accuracy. No part of the sample is lost, as is generally the case with decanting; and an almost dry filter cake is produced in five minutes.

Was Biblical Ophir in the Kongo?

New Theory Advances Idea That King Solomon's Gold Came From the Kilo-Moto Mines

By OWEN LETCHER*

THE recent coronation of Ras Tafari as King of Abyssinia in Addis Ababa—the capital of that little-known kingdom which is one of the only three independent states of Africa—will help to direct attention to a controversy of many years' standing. I refer to the question of the origin of the immense quantities of gold reputed to have been obtained by King Solomon through the medium of the Queen of Sheba.

According to press reports, "On the occasion of the coronation of Ras Tafari the rejoicings continued for several days. The streets presented a gay but barbaric scene of splendor." The new king visited Britain in 1924 when King George restored to him the ancient crown of Abyssinia captured by Lord Napier of Magdala in 1868. Ras Tafari's coronation gives him a joint share in the throne with his aunt, the Empress Juadita. Hitherto he has been regent, but now he is entitled to call himself "King of the Kings of Ethiopia", "Conquering Lion of Judah", "Elect of God", and "Heir of King Solomon and Queen of Sheba". The last title is worthy of particular notice.

Our knowledge of King Solomon is confined to the writings of the Old Testament. In the words of a schoolgirl who was asked to state all that she knew concerning King Solomon: "He was a great and wise and noble king and", the young lady added as a sort of afterthought, "was passionately fond of animals". It is stated that the schoolgirl's "marm" commended the child's version, remarking: "That is quite right, Muriel, dear, but where on earth did you get hold of that idea that he was passionately fond of animals?" Whereupon Muriel answered, "Mam, I am sure that I read in some book—I think it was the Bible—that King Solomon was the gentleman who kept three hundred porcupines"!

We may let pass Muriel's slight *faux pas:* the fact remains that the porcupine is an animal which is found over an extensive portion of Africa. And if the teachings and tenor of the Bible are not to be wholly disregarded, we must admit that there is nothing very incongruous in the suggestion that King Solomon and the Queen of Sheba had an heir. This article is not, however, as much concerned with these two romantic figures as with the treasures which they secured, and it may be remarked at the outset that the fires of historical controversy have for many years raged around the question of the source and origin of all that gold.

That gold has been exported from South Africa for many centuries cannot be doubted. According to some authorities, the discoveries at Zimbabwe—the wonderful ruins in the Victoria district of Mashonaland—establish the close relation of those buildings to the

*Fellow Royal Geographical Society.

Left—An ancient working in Southern Rhodesia reopened by a gold-mining syndicate. Top—A face 75 feet deep in the Camperdown, another large old working in Rhodesia. Bottom—Recovering alluvial gold from the Angwa River, Mashonaland. Gold has probably been won from alluvial deposits by the natives of South Africa since the dawn of time.

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A stretch of typical hill country in Abyssinia where the mule is the principal means of communication.

gold trade and point to a connection between the Port of Sofala, near the mouth of the River Pungwe, and Sabaea or Sheba in Southern Arabia.

The source of supply was known to the Arabs of India and of the Red Sea; and the Portuguese, on their arrival about 1500, found Arab communities established on the coast from Sofala to the north of Zanzibar. Although there is a curious lack of documentary evidence, there can be no doubt that mining was carried on under Portuguese supervision within a few years of their first appearance on the coast; and its discontinuance was probably due to the advent in the mining areas of natives of greater fighting ability than those whom the Portuguese had originally found there.

Southern Rhodesia is studded with ancient workings. Several more or less vague and nebulous estimates, based apparently on the cubic contents of the excavations with a rough guess at grade and extraction, have been ventured with regard to the output of gold that was secured from those ancient workings in Southern Rhodesia and Manicaland. One of those estimates has placed the amount as high as £75,000,000 sterling; but it must be realized that such a calculation is based on the most indefinite data and can at the best be regarded only as a mere shot in the dark. And as T. A. Rickard questioned in a letter which he wrote to me some months ago: Where did all this gold go? By what nation, by whom was it absorbed? Surely the production of such a large amount of the precious metal would have made its mark on history? And if we get down to actual hard historical facts in so far as they are ascertainable, it must be admitted that there are no very reliable pages in ancient history stamped with the impress of all this gold that is alleged to have been produced in remote times.

There are two main schools of thought in regard to the age of the Rhodesian gold workings and the source of the gold that King Solomon became possessed of through the kind offices of the Queen of Sheba. The doctrines of the one school are admirably expressed in R. N. Hall's *Ancient Rhodesia*, in which many arguments are ably marshaled in support of the view that what is today known as Rhodesia was the Ophir of the Bible. On the other hand, Prof. Randall MacIver, in his *Medieval Rhodesia*, just as forcibly contends that the ancient gold workings of Rhodesia date from the Middle Ages, when Spain was reaping rich harvests in the New World and the Portuguese were exploiting Africa and the East.

Between these two lines of argument one may let one's fancy and imagination dwell on many unchronicled pages of history and conjure up visions of Sabaean adventurers or conquistadores invading savage Africa and then sailing away with their booty in their cockleshells of boats at whatever date one's own imagination can best decide—and it must be mainly imagination which is to depict these romantic pictures, because the truth is that South Africa hardly can be said to have any history prior to the appearance of Europeans. The art of writing, even in its most primitive forms, apparently never was known to the natives, and intertribal warfare has obliterated tradition. The occasional discoveries in river beds and recent alluvial deposits of stone implements and weapons prove the country to have been inhabited from very remote times; but we may infer that those peoples, whoever they were, never really rose above the condition of savages.

Iron, however, must have been produced during many ages in the north of the Transvaal, and copper undoubtedly was mined for a lengthy period both in the same district in Namaqualand and in the South West Territory. The tribes occupying the region between the Limpopo and the Zambezi rivers prior to the advent of the Matabele, about 1837, were sufficiently advanced to extract gold and iron from ores, to barter the product for other commodities, and to surround their villages with walls built of squared blocks of stone. It is in this region that we are confronted with the problem presented by the numerous remains of ancient buildings and mine workings of foreign origin.

At least 500 such ruins, extending over an

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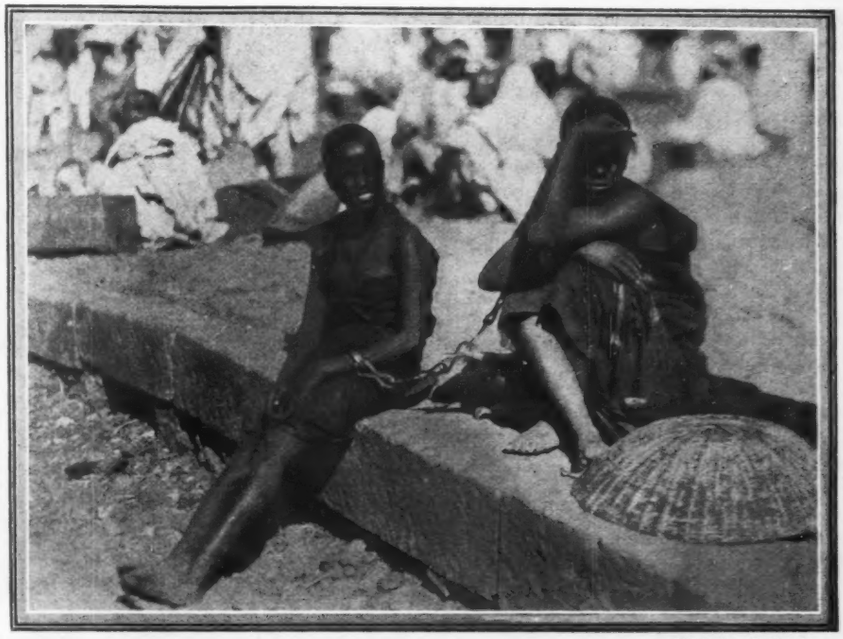
A mounted Abyssinian soldier and his gun bearer on their way to the drill ground.

area of 800 by 700 miles, are to be found in Rhodesia. These apparently date from several epochs—the first showing signs of most skill and the last probably being mere native imitations. The ruins of buildings at Great Zimbabwe, at Mombo, at Tati, on the Impakwe and Sabi rivers, and elsewhere, seem to have been strongholds where foreign traders controlling the gold were stationed.

The measurements and orientation of the ruins; the abundant traces of Phallic worship found there; the erection on the temple walls of the hawk or vulture—the well-known Assyrian and Phoenician symbol for Astarte or Venus; the Goddess of Mines to whom the region of Sinai in Arabia was especially sacred, all these would denote that the buildings were erected either by or under the influence of one of the branches of the Semitic race. The only reliable trace of the age of the earliest ruins is probably that afforded by the builders' religion which seems to prove that they antedate the Koranic era and are not later than the sixth century.

The architecture of the buildings at Great Zimbabwe very much resembles that of ruins to be seen in Syria, the combination of fortress and temple being apparent in both cases. It is possible, or even probable, that the architects were Sabaeans who are known to have traded with all parts of the Indian Ocean both during and before the time of Solomon. Implements that have been dug up show that the gold was smelted and purified within the walls of the buildings; and successive layers of broken refuse prove that several different peoples occupied them after the disappearance of the first owners.

When maritime supremacy in the Indian Ocean passed out of the hands of the Sabaeans, the knowledge of the African Continent, which they had so jealously guarded, soon became the property of the Arabian navigators whose ports, in time, were scattered along a great extent of the littoral. By means of these seafarers communication between Mashonaland and the outside world was maintained for centuries—a vestige of this ancient trade surviving in the Arabian dhows which still serve a useful purpose in collecting produce from the many coastal villages and river mouths.



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In Abyssinia the practice is to chain a debtor to his creditor until the money is repaid. This custom must have its drawbacks.

The foregoing represents very briefly some of the arguments advanced by the ancient Rhodesian school of belief championed by Hall, Count Wilmot, Carl Peters, and numerous others, and recently strongly reinforced by Dr. Leo Frobenius, a distinguished German scientist who is now investigating the antiquity of Zimbabwe and of the old mine excavations in its vicinity.

As against these arguments one may set one or two contentions of the medievalists. With regard to Zimbabwe and other ruins, for example, they point out that in no case have any inscriptions been found; and none of the glass or pottery unearthed appears to date further back than the thirteenth or fourteenth century A.D. Some lettering on the glazed pottery is all post-Koranic. In spite of the presumed connection between Sofala and the country governed by the Queen of Sheba there is no proof, say the medievalists, that this part of Africa was the Land of Ophir spoken of in the Bible.

If we are to accept the belief that the Ophir of the Bible was not in Rhodesia at all, one may pertinently inquire: "Where, then, was this land of fabled wealth?" A new line of thought and an avenue worthy of research is suggested by the idea that Ophir was situated in the region of the Kilo-Moto gold fields in the northeastern section of the Belgian Kongo.

I now put forward the theory that this remote auriferous region may have been the source of the precious metal which enriched King Solomon; and I suggest that access to this area via Lower Egypt and the Nile may have been a factor worthy of special consideration in seeking to evolve a problem which has proved such a bone of contention for many centuries amongst archeologists and historians, explorers, and gold seekers. There are many points which appear to be worthy of consideration. Especially interesting is the question of the availability of a river and road route in or adjacent to the Nile Valley. That such a means of entry into the heart of Africa was known to the ancient civilization of the Pharaohs appears to be quite a reasonable conjecture.

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Abyssinian warriors are not only picturesque but a formidable lot to battle with.

The crude boats that one may observe in actual use today on the upper Nile are almost like those in which the Phoenicians navigated so many of the seas of the Old World. It is probable that the first floating craft ever built was constructed out of dried, compressed grass on the upper Nile; and there is certainly nothing fantastic in the idea that many centuries ago, when the upper Nile in all likelihood was not choked by sudd to anything like the degree to which it is now, the ancient Egyptians had trade intercourse via the Nile with the regions of the great lakes, the Ruwenzori Range or the Mountains of the Moon, and possibly with the rich and extensive Kilo-Moto gold fields lying to the west of Lake Albert.

Quite recently, "Gerry" Bouwer, the intrepid South African motorist, made an adventurous dash through Africa in a Chrysler car; and over a portion of his journey he followed, so he said, an ancient Egyptian and Sudanese trade route. I may also mention that a year or two ago I read with great interest a book, published in London a century before Speke and Grant discovered Victoria Nyanza, in which the adventures of an Italian—one Gaudentia di Lucca—were described. Di Lucca, according to his account of that eventful journey, was taken into captivity and, when in bondage, traveled by land and up the great river until he reached a country which tallies fairly closely with Uganda. That romantic journey may only have been a *voyage imaginaire*, but the Italian's tale seems to strengthen the idea that many centuries ago there was a means of communication between Lower Egypt and the heart of Africa. If that be so, it is surely not unreasonable to suggest that goods of some kind were transported from Ethiopia to the civilizations of the Eastern Mediterranean. What more likely than gold? And why not from Kilo-Moto? One argument used against this is that there are no ancient workings in the Kilo-Moto fields—at least none, as far as I can ascertain, have been found there. But we know that these fields are immensely rich in gold-bearing alluvials; and it is surely logical to assume that the primitive gold seekers would take the line of least resistance and not sink shafts into the ground whilst an abundance of the precious metal was to be won from surface alluvials.

In so far as one can ascertain, the existence of gold and probably of platinum in that region of Africa—which contains the headwaters of the River Nile—was known to the natives inhabiting this territory and more particularly to the royal house of Uganda and its councilors centuries ago.

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His Imperial Highness Ras Tafari in all the glory of his royal regalia.

Though there is a great deal of more or less vague tradition as to the winning of gold from the deposits lying on the Nile-Kongo divide during epochs now so remote that time has drawn an impenetrable curtain across the scenes, and though there seems to be ample ground for presuming that this region was the Ophir of the Bible, still nothing very definite is known of its mineral resources until we come down to comparatively modern times.

The Uele River flanks the northern portion of this mineralized region; and during the late seventies of the last century Schweinfurth, Junker, and Emin Pasha and his Egyptian agents traversed a large part of the Uele region. The country in the vicinity of the Moto Mine was explored by the Vandekerkhoven Expedition in 1891 and 1892.

Some examples of African gold nuggets.

The first occupation of this Haut-Ituri district was achieved in 1894 by Colonel Lothaire, a fine. commanding figure of a man who seems to exude the romance of Africa. In 1894 Lothaire. when in pursuit of the murderers of Emin Pasha, established a post at Kilo, occupying Mahagi on Lake Albert. Revolts and massacres of Europeans followed; but in 1899 the Haut-Ituri district was formally occupied and posts were established at Irumu, Kilo, and Mahagi.

Up to the time of the conclusion of the Anglo-Boer War in the far South, the Government of the Kongo Free State had paid little attention to the mineral resources of this area. But the discovery of gold in the Transvaal and in Rhodesia, and later at Ruwe in the Katanga, induced nearly all African administrations to explore their territories for similar wealth. In 1902 the Kongo Free State Government, acting on the advice of the Geologist Dupont, decided to dispatch an expedition to prospect the primary formations in the vicinity of Lake Albert bordering on the great rift that runs through the African continent. Two Australian prospectors—Hannam and O'Brien by name—were accordingly engaged; and they reached Irumu, which lies to the east of Kasenye on Lake Albert, in January, 1903. After unsuccessful searches for mineral wealth to the north and in the vicinity of Mahagi, Hannam at last found gold-bearing gravel in the bed of the Agolo River. The expedition returned to Belgium at the beginning of 1904, when the members were instructed to commence the exploitation of the placer deposits discovered.

They again reached the scenes of their labors at the end of the same year, and established a camp at Kilo in the Bambisa country. The name of Kilo has been applied to the mineral region as a whole, and denotes the gold fields around the Nizi, Agolo, Shari, and other rivers. The prospecting carried out along the banks and in the beds of these streams revealed the existence of sufficient quantities of gold to insure profitable working for a great number of years; and the state thereupon reserved to itself exclusive mineral rights in the basin of the Haut-Ituri from Irumu as far east as Lake Albert.

In 1906 Hannam, continuing his prospecting expedition toward the north in the Uele River basin, discovered gold-bearing gravel in the valley of the River Moto—a minor tributary of the upper Uele. The name Moto was given to this gold field. Active operations were commenced there in 1911, six years after the Kongo Free

State began the exploitation of the gold-bearing gravels of the Kilo area. The methods of recovery as at first employed were of a most primitive nature. Gravity separation was carried out by means of crude riffles and sluice boxes and rough concentrating tables. But gradually, and despite enormous transport difficulties, the mining region was placed on a sound productive basis. Eight Chilian mills were originally acquired in South Africa, and in 1923, to supplement the Chilians, the committee of management ordered a battery of four Nissen stamps capable of crushing 3,000 tons of quartz a month.

In 1921 the state launched a central hydro-electric power project for supplying 1,500 h.p., generated at the Shari River, to the Nizi Mine, and six years later a cyanide plant with a capacity of 200 tons a day was installed. Much of the plant at the Kilo mines was supplied by the well-known Rhodesian mining machinery firm of Johnson & Fletcher, Ltd. Mr. H. Clarkson Fletcher, as the result of a visit to the field, has rendered the government valuable advice in regard to the most useful type of plant to be installed under the existing exceptional conditions and particularly in respect to the transportation of heavy machinery. Additional equipment—comprising compressors, locomotives, a small stamping plant at Moku, etc.—have been provided in the meantime.

Numerous other reefs besides those at Nizi have been discovered and developed, and amongst the most important of these in the Moto region are the Kosekia, Moku, Miro, and Elena ore bodies. In the whole Kilo-Moto gold fields the number of workers employed is approximately 200 whites and 19,000 natives. Sometime ago the gold reserves in the mines were estimated at 836,000 ounces, worth more than £3,500,000, but we know now that the reserves in the original Kilo and Moto properties alone contain a far greater amount. In fact, it is most important to note that during the past few months there have been made other discoveries which point to the existence of a much larger gold-bearing field than had been reckoned on previously.

During recent months important new areas of alluvial have been found along the banks and in the bed of the Kibali or upper Uele, between the Arebi and Yebu rivers. These deposits are estimated to contain 643,000 ounces of gold valued at £2,750,000; and it might be added that 21,500,000 cubic yards of gravel already have been proved to contain 300,000 ounces of gold equivalent to about £1,600,000. Further borings made toward Niangara, in the extreme western section of the concession, have proved the existence of additional alluvial areas. It has also been determined recently that the Gada River, a southern tributary of the Uele, is gold-bearing.

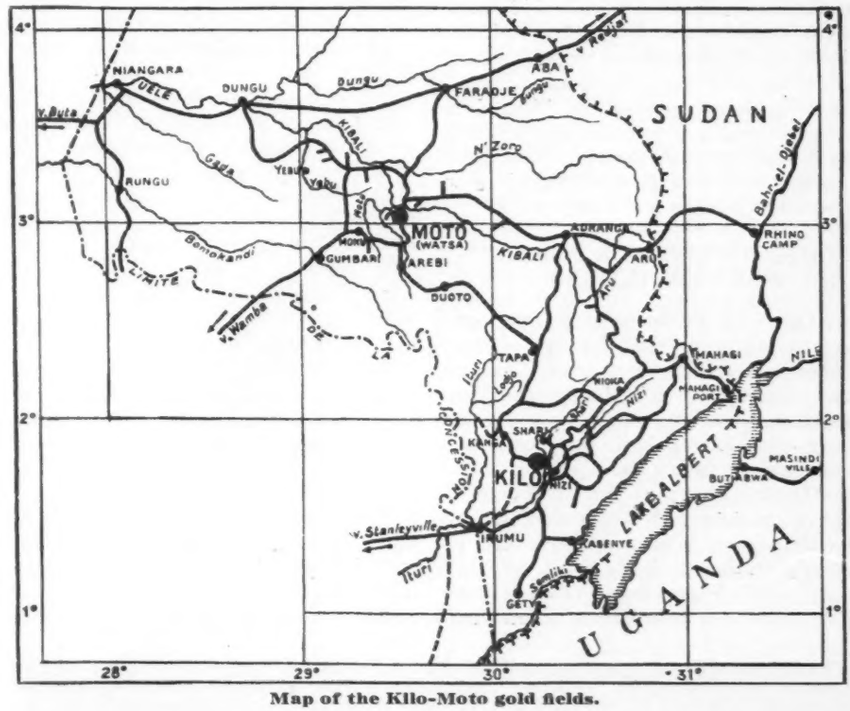
This whole area is now producing approximately 140,000 ounces of gold per annum, and the output from the rich alluvials—which I suggest may have been worked by the natives themselves or, more probably, by alien traders or conquerors centuries ago—is likely to increase rapidly. Moreover, increased yields may be expected from the reef deposits, for the mines are being equipped with new plants, including air compressors and "Jackhamers"; efficiency is being speeded up; and methods of work generally are being improved.

It will be gathered from the figures of production already given that the Kilo-Moto region is a gold field of no mean importance; and to my mind there is no question that it is the most romantic gold field of the world. In dwelling on this subject, one does not have to have much imagination to let it run into all manner of fanciful channels and into the backwaters of romantic history. One can visualize pictures full of the surge of adventure and the lust of treasure around which so much of the story of mankind has been written. One can picture the commercial captains of the Pharaohs paddling their ways up the mighty Nile—the very mother and nourishment of Egypt—until they reached Ethiopia and the region of barbarians who had ivory to barter and whose country contained the gleaming nuggets of that precious metal which has emblazoned the pages of history with achievement, stained it with lust, and crimsoned it with blood. One can imagine those treasures together with vast hordes of slaves brought into Lower Egypt to be afterwards placed at the disposal of a king of Judea.

The scene changes—the centuries pass by and still we see this region under the iron heel of the conqueror and raider, in this instance the Arabs. The years roll on and we see Schweinfurth, one of the great explorers of the Victorian regime in Africa, wandering through the heart of Africa. Schweinfurth was the first white man to penetrate this region. A little later and we observe brave Commandant Lothaire establishing in the Kilo-Moto country an outpost for his king, Leopold of the Belgians; waging war against the Arabs; and fighting disease, desertion, and difficulties of almost insuperable character. Next we may observe those tough Australian prospectors searching for gold just as the prospectors of the Pharaohs did centuries before in this wild and hilly country that marks the contact of the region of the great lakes and the Mountains of the Moon on the east and the vast equatorial forest belt of the Kongo on the west.

Today, after the Belgians have brought this gold field to a remarkable degree of industrialization, when hydro-electric plants are at work, and when compressed air is supplying power to rock drills for the mining of the reefs from which so much alluvial gold has been shed, the scene that meets the eye is a different one. Looking a little further ahead, we can visualize an airplane service linking Kilo-Moto with the "Sabena" aerial lines of communication at Coquilhatville and thus transporting the gold from this field to ocean-going steamers at the mouth of the Kongo. For such a project is contemplated and is likely soon to be *au fait accompli*.

What a wonderful kaleidoscope it all provides! How true it is that out of Africa always comes something new. At least so it seems. Yet, in reality, what we account new is probably very old and has merely been covered with the dust of the ages and the myrrh of millenniums. And so I fancy that the Kilo-Moto gold field was not discovered but rediscovered by Hannam in 1903. The first creature who found the grains of gleaming metal along the Shari River probably lived so long ago that he had scarcely parted with a tail!



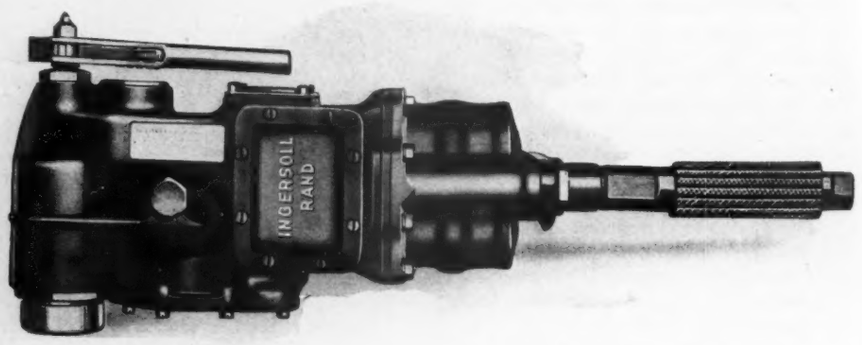
Map of the Kilo-Moto gold fields.

NEW AIR-DRIVEN DRILL FOR CLOSE-QUARTER WORK

A NEW gear-driven drill, with a 2-cylinder double-acting motor, has been put on the market by the Ingersoll-Rand Company for drilling, reaming, and tapping in close quarters. This drill, designated Size 90, is said to develop approximately 20 per cent more power than older types of close-quarter drills—the resulting increase in torque proportionately reducing the tendency to stall.

The tool is flat, and substantially of the same thickness from the spindle to the cylinders. This is a great advantage, as it enables the drill to be used with facility in very cramped places. It has an over-all length of 9¼ inches; weighs 41 pounds; and is fitted with spindles with No. 4 Morse taper sockets.

The new drill is rugged in construction, and the working parts operate smoothly because of the arrangement of the piston—which acts at right angles to and in a plane with the spindle—and because of the employment of anti-friction bearings, a counterbalanced crank, and special gears for the drive. The gears are strong, and their size and strength increase with the load until the final drive on the spindle is through a herringbone gear that assures a smooth and steady action.



Newest Ingersoll-Rand close-quarter drill which is a distinct improvement in power and durability over older models.

VANCOUVER ADDS TO HER PORT FACILITIES

VANCOUVER, British Columbia, the western terminus of the Canadian Pacific Railway, is in a fair way to realize its ambition to become one of the biggest and best-equipped ports on the Pacific coast. Only recently a mammoth pier was completed there for the Canadian Pacific at an outlay of $6,000,000. This pier, with its length of 1,140 feet and more than double that amount of berthing space, is in striking contrast to the first wooden-pile docks built by that railroad in 1887, when Vancouver was a place of little more than possibilities. Since that time much has been done to provide adequate facilities for the steadily increasing tide of shipping to and from Vancouver, which has one of the finest natural harbors in the world.

Piers B and C, as they are designated, were designed with an eye to the future. The structure is capable of berthing two of the largest liners afloat today, and is roomy enough to take care of the cargoes of twelve such ocean greyhounds. However, the biggest of the transpacific boats that will be docked there at the present time have a length of but 640 feet, thus making it possible to accommodate besides, on either side, another but smaller vessel. In addition, because of its width of 331 feet, a moderate-sized craft can be brought alongside the offshore end while both sides of the pier are occupied.

One novel feature of this new pier is the promenade on each side for the convenience of passengers. These walkways lead from the head house over the roofs of the freight sheds to the ships' gangplanks, permitting embarking and disembarking to proceed without interfering with the handling of freight on the lower decks. While intended primarily for the use of its own ships, the Canadian Pacific Railway is allowing boats flying other house flags to dock at piers B and C.

This great steel-and-concrete structure, that embodies all the latest improvements in design and all the most modern facilities for expediting the turn-round of vessels, is evidence not only of Vancouver's rapid development but also of what may be expected of that enterprising Pacific seaport in the not-far-distant future. The pier was built by the Sydney E. Junkins Company, Ltd.

Photo, Leonard Frank

The Canadian Pacific Railway pier, in Vancouver Harbor, which is said to be the second largest in the world. The erection of this great structure was expedited by the use of air-operated equipment in the form of riveting hammers, a cement gun, etc., drawing compressed air from a 9x8-inch Type 20 portable.

ENORMOUS CONDENSER FOR POWER STATION

THE New York Edison Company is now installing at its great East River Generating Station a 160,000-kw., single-shaft, single-unit, turbo-generator which is said to be the largest thing of its kind in the world. And there is also being assembled as an auxiliary to this generator a truly enormous Ingersoll-Rand, single-pass, surface condenser that will be able to handle hourly nearly 700 tons of steam exhausted from the turbine that will drive the generator. In order to condense this steam, so that it can be turned back into hot water for refeeding the boilers, the steam will be exposed to 90,000 square feet of cooling surface within the condenser. This cooling surface is made up of enough ⅞-inch tubes—each 26 feet long—to cover a distance of a trifle less than 80 miles, if placed end to end.

The cooling water sent through the tubes of the condenser in the course of an hour will amount to 40,000 tons—sufficient, in fact, to float a vessel of the size of the *Mauretania*. The condensing water will be drawn from the East River, and will be circulated through the condenser at the rate of 160,000 gallons a minute by two 54-inch centrifugal Cameron pumps. As soon as the water has performed its cooling service in the condenser it will be returned to the river.

Investigators working in the Dairen laboratories of the South Manchuria Railway Company have succeeded in obtaining about 70 per cent of heavy fuel oil from coal pitch heretofore considered waste matter. The commercial side of the discovery is now engaging the attention of the scientists.

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European Correspondent
144 Leadenhall Street, London, E. C. 4

EDITORIALS

RESPONSIBILITY

THIS topic was probably the one most discussed during the December meeting of the Northern California Chapter of the Associated General Contractors of America. The aim and the purpose of the organization is to make membership in the association a reasonable assurance to the public of skill, integrity, and responsibility. The general contractor enjoys a distinctive position in our industrial life because, in the last analysis, it is he that must execute, must carry to their intended climax, the designs and plans evolved by the construction or civil engineer. Ultimate success in such projects, today involving annually the obligation and the expenditure of many hundreds of millions of dollars, depends upon the skill and the responsibility of the men that actually do the work—the contractors.

The field of service has attracted many that are not qualified to undertake such contracts because of a lack of skill, a deficient organization, or financial inability to carry their share of the burden. Therefore, it should hereafter be required that a contractor establish his responsibility before his bid receives consideration. Such an attitude on the part of those making awards will save many painful occurrences and, incidentally, prevent the squandering of very large sums of money every year. The Associated General Contractors of America stand solidly behind this proposition, because they recognize that only in this way will it be possible to do away with the questionable practice of awarding contracts, as is so often the case, to the lowest bidder assumed to be responsible merely because he has subscribed to certain matters of form. The Comptroller General of the United States Treasury Department has, in effect, ruled that responsibility rather than price should be the first concern of the awarding official. This is significant in view of the preference long enjoyed by the lowest bidder.

Responsibility is something that can usually be ascertained in advance of awarding contracts; and the splendid proportions of so many of the projects carried to completion by contractors only serve to emphasize the wisdom of first making sure that the successful bidder is in all respects equal to the responsibilities placed upon him.

OVERPRODUCTION OF PAPER FEARED IN CANADA

NO inconsiderable part of Canada's industrial prosperity hinges upon her output of newsprint; and the country has reached the point where steps must be taken to regulate output. This was emphasized by certain remarks made a short while back by Sir JOHN AIRD, president of the Canadian Bank of Commerce. The following quotation is taken from the *New York Times:*

"The dark spot on the horizon of the business situation in this country is the overproduction which has occurred in the pulp and paper industry. That an industry in which over half a billion dollars of capital is invested, which employs many thousands of people, and the products of which rank second in value among our principal exports, should be in an unprofitable condition through overproduction and competition seems inexcusable.

"If for no other reason, the fact that one of this country's principal natural resources, the supply of which is strictly limited, is being sacrificed at bargain prices because of overproduction should be sufficient to cause those responsible for this state of affairs to pause and to put forth their best efforts to remedy the situation without delay". Sir JOHN urges that the administration of Canada's forests be put upon a proper scientific basis. Wastefulness is the usual outcome of a natural plenty and of a lack of appreciation of the inevitable day of shortage unless steps be taken to conserve the raw product or to promote its reproduction where possible.

Americans may have to face the same situation if they turn to Alaska for any considerable part of their pulpwood. We are authoritatively informed that Alaska can furnish us annually millions of tons of newsprint raw stock, and can do this in perpetuity provided care be exercised in cutting the timber and in replanting. We wonder whether control in Alaska would be any more effectually exercised than it has been in Canada.

Most of us know what has been achieved in some European countries in the way of safeguarding their timber lands and in stimulating—in fact insisting upon—reforestation. What those people have shown to be practicable and profitable we, as well as Canada, should be able to duplicate.

GIBRALTAR STRAIT TUNNEL PROJECT REVIVED

A TUNNEL under the Strait of Gibraltar is measurably nearer. thanks to the active stand taken by the Spanish Government in calling together a commission of experts to reconsider the project which has recurrently been the subject of discussion over a period of years. It seems that King ALFONSO is deeply interested in the scheme, and is heartily desirous of seeing it taken in hand if not carried to completion in the near future.

There are, so it has been said, no insuperable physical obstacles in the way of driving a tunnel through the rock beneath the Strait of Gibraltar. Air-driven rock drills, air-operated mucking machines, and electrically propelled mucking trains are available today and capable of meeting any needs of the tunnel drivers; but, even so, there remains the tremendous sum that would have to be expended in making such an enterprise an effective economical rail link between Europe and Africa.

At its narrowest part, the Strait of Gibraltar is only a trifle more than eight miles wide—a distance shorter than that covered by several existing tunnels; but in order to pierce solid rock the tunnel drivers must carry their line well below the bed of the strait, which lies on an average of more than 1,000 feet below the surface of the Mediterranean. Therefore, in order to avoid prohibitive grades in mounting toward the portals, the tunnel must be made miles longer. Indeed, the tunnel may measure more than 30 miles between portals so that it will subscribe to the operating requirements of modern railway practice.

It calls for no stretch of the imagination to grasp the vast magnitude of the volume of rock that must be drilled, blasted, and then handled by mucking trains in order to carry the work forward with acceptable speed—that is, at a rate of advance that would open the route for service before it had entailed a prohibitive outlay. As it is, it is estimated that the project would involve the expenditure of substantially $40,000,000. This sum should prove no deterrant if economic conditions would seem to warrant the consummation of such a scheme.

Those most earnestly in favor of the undertaking point out that the tunnel would furnish a new and profitable outlet for the wealth of interior Africa, and provide a through rail route between Europe and the southernmost tip of Africa—in other words extend by thousands of miles the rail link that will soon join Cairo with Cape Town. Undoubtedly, a tunnel under the Strait of Gibraltar would save much time in the movement of freight and passengers between Europe and Africa; and in the course of years the volume of this service would inevitably increase. The problem now is whether existing conditions and the outlook in the near future would justify so gigantic a venture. Can't the sum be better spent elsewhere? We shall await with interest the publication of the report to be made by the commission of experts that now have this subject under advisement.

OUR COMMON AID THE AIR

WE seldom stop to think of the importance which familiar air has assumed in recent years. We know, of course, what an indispensable part air plays in sustaining life; and we also know that through what might be called the power of air the world was civilized by the pioneers who sailed in ships and who cultivated, developed, and subdued the earth. It is truly remarkable, however, that the capacity of air to transmit power and to make itself still more useful to the human race has been realized only in recent years.

The airplane, the Diesel engine, and the radio are different examples of this—all being modern creations. Navigation of the air has been made possible through compressed air ignited and expanded in combination with gasoline. Of radio we know relatively little except that by it sound can be transmitted through the air and reproduced with the aid of an amplifier. The Diesel engine, which up to date produces a horsepower at lower cost than any other mechanical agency, is largely dependent upon compressed air which, while not actually furnishing the power, serves nevertheless as a valuable auxiliary.

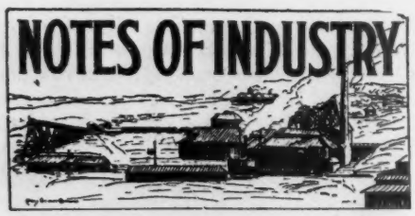
The automobile is one of the most useful and most widely employed machines that use compressed air. It is air that pushes the pistons when expanded through internal heating by the instantaneous ignition of the gasoline with which it is mixed. This is striking evidence of the power of compressed air when its temperature is suddenly raised; and we all know how the motor car is adding to our pleasure and convenience as well as to the general prosperity of the nation.

We little grasp how wide is the use of air in industry. Numerous pneumatic tools are proof of this. They are employed in shops, in steel construction, in drilling and chipping work in the street; and their capacity to do their work well and rapidly has brought about savings amounting to many millions of dollars. Tunnel driving on the scale now pursued would not be economically possible but for the air-driven rock drill, which, in mines and tunnels, gives us the economic equivalent of mass production. The submarine, one of the most remarkable of modern war craft, is absolutely dependent upon the services of compressed air.

In this brief reference to the general and widespread usefulness of compressed air, merely some of the high spots have been touched upon; and we must not forget how compressed air is lifting oil and water from deep wells and doing many other essential and helpful things too numerous to mention. Enough has been said, however, to indicate the diversified applications of compressed air and to emphasize the part it plays in the scientific and the economic development of industry.

W. L. S.

During the next two years, British Columbia is planning to increase her present hydroelectric output of 480,000 hp. by 50 per cent at an expenditure of more than $10,000,000.



Ground paper pulp in flush form has been conveyed successfully through a pipe line built by the Thunder Bay Paper Company for its mills at Current River, Ont., Canada. The line, of 10-inch cast-iron piping, has a length of two miles.

The formal opening of the King George's Dock at Calcutta, India, late in 1928, marks the completion of what is considered one of the largest and most important engineering undertakings of its kind in the world. The project, which was started in March of 1920, was built at a cost of $36,500,000.

It is a well-known fact that the United States has the most extensive system of good roads in the world. However, it may surprise some of us to learn that we are estimated to have 97 per cent of the bituminous-macadam, 94 per cent of the bituminous-concrete, and 96 per cent of the cement-concrete highways in existence.

Since the establishment of the Safety Division of the United States Bureau of Mines, more than 250,000 men in the mining, oil and gas, and steel industries have been trained in first-aid and rescue work. This army safeguards approximately 2,000,000 people actively engaged in the fields in question.

Manufactured gas is still mainly depended upon in Paris for lighting purposes. According to the chief engineer of the Société du Gaz, 80 per cent of the city's illuminating system consists of gas lamps.

The energy of the water wheels or turbines set going in Canada during 1928 aggregates 550,000 hp., thus bringing the total for the Dominion up to 5,328,000 hp.

Buenos Aires, Santa Fe, and Cordoba—the three most important provinces in Argentina, are to be linked by a modern highway 390 miles long. A sum of $22,000,000 has been appropriated by the government for the construction of this road.

It is reported from Australia that helium-bearing gas was discovered in drilling an oil well near Brisbane. The find is considered an important one.

It has been estimated that close on to 5,000 air-driven rock drills and other pneumatic equipment are in daily use in New York City in excavating for foundations, in building subways, and in doing other kindred work. This, perhaps, explains why Manhattan is sometimes likened to a mining town.

Nova Scotia's extensive oil-shale deposits, which are said to contain high percentages of oil, are to be exploited as soon as the extraction plant, which is now being built at New Glasgow, is completed.

A scow that can be capsized for dumping and that can carry its load on whichever hold or deck happens to be uppermost when in dock is being operated by the City of Seattle, Wash. Dumping is effected by flooding certain of the craft's buoyancy chambers, which are built along either side.

During 1928, the per capita steel consumption in the United States reached 959 pounds, representing an increase of 124 pounds over the preceding year and a record that has not been exceeded since the days of the World War.

The Physics Department of the University of Toronto has announced the discovery of a machine that measures to the slightest fraction and almost instantaneously the moisture content of any substance. The invention was conceived by Arnold Pitt, a graduate of the university, working under the direction of Dr. E. F. Burton, and depends for its operation on the factor of electrical conductivity. The machine, it is claimed, has lessened the time required for measuring the moisture in a "run" of wheat, for example, from hours to seconds.

The De Clair Laboratories, of Los Angeles, Calif., are offering a reward of $5,000 for the discovery of a peculiar type of limestone which has the property of being extremely sensitive to static electricity. A 12-ounce piece of this mineral, *Mining Truth* informs us, sold recently for $63, or for about one-fourth the value of gold. The De Clair Laboratories will analyze any samples sent them free of charge.

According to its conservation commissioner, New York leads all the states in the Union in reforestation. During the past ten years the number of its municipal and community forests has increased from 79 to 317, and more than 115,000,000 trees have been planted. This is a noteworthy performance, and one that other states might profit by to advantage.

The National Foreign Trade Council will hold its Sixteenth National Foreign Trade Convention in Baltimore, Md., on April 17 to 19, inclusive. All those interested in the development of our foreign trade—whether from the angle of agriculture, commerce, industry, finance, transportation, education, etc.—are invited to participate and to help solve the problems confronting our exporters. For the first time in the history of these conventions a national meeting will be effected of foreign-trade clubs, export managers' associations, and similar bodies to the end that these local groups might hereafter collaborate on all subjects relating to our foreign-trade policy and to stimulate foreign-trade activity.